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Introd. to the plant-life
of the Oxford district.

Vol.2.

INTRODUCTION TO THE PLANT-LIFE OF THE
OXFORD DISTRICT

II. THE ANNUAL SUCCESSION. (Jan.—June)

By

A. H. CHURCH, M.A.

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1. Iffley Lock, July 19, 1922 ; reconstructed 1924.



2. Ditch in Flood Meadows, winter aspect ; Pollard Willows and dead Carices ;
Iffley Lock Field, April 3, 1923.

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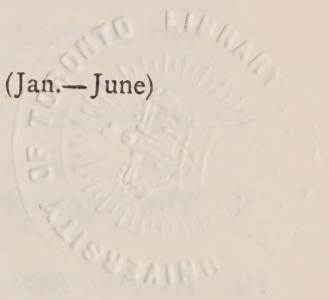
BOTANICAL MEMOIRS. No. 14

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THE ANNUAL SUCCESSION

THE identification of plants and the scheduling of their names in some sort of system obviously implies that something more is required to be done with them beyond mere collection. Systematy demands scientific accuracy, but remains wholly subsidiary and subjective, as an abstraction of the human mind and its literature. Biology deals with the questions of racial origin and progression: the ecological outlook takes cognizance of the daily experiences and possibilities of the individuals. The latter involves consideration of the response of both somatic and reproductive processes to the marked changes of season involved in the extremes of winter and summer of the North Temperate Zone, in sunshine, temperature, and water-supply.

So intimately are these phenomena connected with the appearance and habit of the plants, that it is convenient to do the two things concurrently and from the beginning; since to follow a plant around the year is to become acquainted with it in various phases, and under several different conditions of environment. That is to say, *Field-Botany* consists of something more than merely picking flowers and discussing names of species and sub-forms,—the first step in Ecology, as opposed to mere collection, is to begin with the story of the *annual succession*, as illustrated by the flora of the district concerned.

In so doing, the first point that becomes obvious is that the Flora of even a small district is not one, but contains many associated communities or formations, each with its own set of associated types, with very little overlapping; e.g.—as previously indicated¹—

- (1) *The vegetation of woodland*, as vestigial from the original forest-flora, now under cultivation (forestry) for timber, with associated herbaceous plants of the underwood.
- (2) *The vegetation of the pastures*, as more artificial clearings adapted for the cultivation of grasses, together with a large variety of associated herbaceous plants more or less useful for fodder.
- (3) *The crops of arable land*, also with their more generally recognized 'weed'-flora of the agriculturalist.
- (4) *The aquatics of river and ditch*, as still representative of an ancient swamp-vegetation, probably the least altered of the local formations.
- (5) *The plants of garden-cultivation*, in the great majority of cases alien importations from warmer climates, including the more familiar plants of park-grounds, private gardens, and allotment areas.

For each of these a special flora of at least 100 species may be characteristic; and in each the changes of the season, particularly when exaggerated by the vagaries of human cultivation and interference, work out characteristic effects. It is thus possible, month by month, to follow the annual succession, much as the daily Press may keep columns for 'Topics of Agricultural Interest' (3), 'Horticultural Notes', 'The Garden Week by Week', 'What to do in the Allotment' (5),² though beyond casual attempts at 'Nature Study',³ little importance is attached to the more biological aspects of woodland, pasture, and stream, which thus fill the gap as the story of sylvestral (1), pratal or agrestal (2), and paludal or riparian floras (4).

¹ Botanical Memoirs, 13 (1922), p. 52.

² 'Seasonable Gardening' by Thos. Trollope, F.R.H.S. (1923-4), Oxford Journal Illustrated, weekly.

³ 'Nature Notes from Oxfordshire' (1923-4), Oxford Times, weekly.

The keeping of such a record for some 500 plants, which with the addition of aliens and lower forms may be readily extended to 1,000, will be found to occupy all one's available time during the short summer season; hence the completion of even such elementary work is commonly spread over several years, and the results of one season can be averaged up with those of others, with further insight also into the effect of climatic variations. Such observations are by no means restricted to the appearance of the flowers as a mere phaenological record. For each plant it is useful to chronicle the appearance of the first functional flower, the culmination and duration of the maincrop, and the last flowers of the season, as giving the full range; and with this the time of the maturation of the fruit, the first ripening of the seed, as also that of the maincrop,—the elaboration of the mechanism of perennation, the relation of the flower to correlated insect-life with an annual periodicity of its own,—as also the adjustment of the dispersal mechanism and its working efficiency. The fact that these things may have been described, more or less, in other countries, or are accepted generalizations of the English Flora, or may even be the commonplace of the text-books, does not affect the main question, that such data require to be verified by the individual himself, for the particular district he may be in; while in doing this for the Oxford District in connexion with a Botanical Department in which laboratory observations can be carried out simultaneously, the student is receiving a training in practical observation which is the first desideratum for all botanists passing on to the examination and exploitation of the flora of distant lands.

In dealing with the vegetation of such a restricted area, it will soon be noted that some plants are extremely *common*, so much so as to attract the attention of even the non-botanical, and be given popular names. Others are less common, but when looked for prove to be widely and generally distributed; others again are *rare*, occasional, sporadic, only seen at long intervals or after protracted search. It may be pointed out at once that the collector is always more interested in these last, and prides himself on his skill in detecting them; but the special business of the ecologist is with the first mentioned, as the plants there is no escaping; while the great intermediate class constitutes the bulk of the species in the flora. An ecological list of some 500 plants will include some 100 as extremely common and familiar, even dominant, as the essential working members of the floral community.

The meaning of this is significant. In a tropical forest, with all the conditions for plant-growth at an optimum, nothing is more striking than the immense variety of tree-type.¹ No one form is dominant, every plant in sight is different. That is to say, under optimum conditions of environment, all progressive lines of flowering plant are competing against each other on fairly equal terms, and with indefinite possibilities for variation, as they effect compromises in the different relations of somatic and reproductive organization; and thus representatives of Apetalous, Apocarpous, Gamopetalous, Calycifloral, or Cistifloral, and even Monocotyledonous families may all grow in a general mixture side by side. But, beyond the primary forest-zone, as the conditions of life become more strenuous, and the major problems lie in combating the physical disadvantages of soil, climate, and season,—with shorter working hours, or exposure to the desiccation of heat and cold winds,—the competing forms diminish in number, until the conditions become so difficult that only one or two types

¹ Cf. Wallace (Travels on the Amazon): 'One can scarcely ever see two individuals of the same species together: generally the same species of tree is repeated only at distant intervals'; cases are recorded of trees 10 miles apart, and the impossibility of getting uniform timber output noted.

are left with all the space to themselves; or, again, associated forms may occupy the station at different times of the year, thus becoming complementary, and inducing a succession of a few dominants.

In fact, the farther one is removed from the optimum conditions of a tropical rain-forest, to cold Northern latitudes, with short light-season, and temperature not necessarily co-ordinated with the available water-supply, the three factors of *light*, *temperature*, and *water*, exert a rigidly selective influence in determining the survival of types, whatever may have been the original line of Angiosperm evolution from which they have sprung. In the limit, edaphic conditions of the nature of the soil and substratum, as also its water-content, climatic factors of rainfall, elevation, and latitude, with the seasonal rhythm of alternating periods of wet and dry, hot and cold weather, give combinations so exacting in their demands that one type alone may satisfy them. Hence with the ground left free from other competitors, this surviving type becomes dominant and preponderant; while the unsuccessful dwindle to a wholly subsidiary position, or become very rare before being finally extinguished. In suchwise, every special station, with special physical conditions at different times of the year, may carry its preponderant type, as the present product of the rigorous sieving process of natural selection—'common' in the popular sense, though often of little aesthetic value or sentimental interest,¹ but the more interesting biologically as the most enduring survivors of their race. Conversely, the more preponderant and common a form, the more definite should be the complex of external conditions to which it responds, and the greater its interest to the ecologist in working these out. Rare and vanishing forms also become the more interesting as the causes of their elimination become apparent; and not merely because they acquire a value in virtue of their rarity in the manner of a rare postage stamp. The assumption that a common type must be a 'generalized' type, capable of growing 'anywhere', is based on the fallacy of garden-cultivation, in which unoccupied ground with favourable conditions of soil and water-supply are given to all plants quite impartially; and the vast majority of plants respond with alacrity to good treatment, in which, that is to say, the most insistent factors of their general struggle are wholly eliminated.²

The general result will be that every special class of station, that is at all available for plant-life, will have its special occupant at any given time of the year. The less extreme situations will carry several competitors; and at the optimum growing-period will be found the greatest variety of forms in open competition with each other, rather than struggling against the defects of the climate. The climatic factor is responsible more particularly for the annual succession in occupied ground, as different types come on and run their course following changes in the physical conditions as a consequence of seasonal periodicity.

In giving an account of the actual state of the annual succession as observed from month to month, the object in view will be to determine how much is due to any special adaptation to suit the present physical conditions, and how much to inherited biological equipment, as illustrating the effect of such *natural selection*: but also the extent to which the conditions and results may be modified by human agency, which now in every province of the present flora upsets the original mechanism of competition by providing new possibilities of unoccupied ground, tillage of the soil with new crop-associates, and new growth-periods. These last imply an added *artificial selection*, even apart from any intentional effect on the plants

¹ Cf. *Ulex* of denuded waste and *Calluna* of the Heather-moor.

² Cf. Docks, Chenopods, Sting Nettles, Polygonums.

concerned,—whether *unconscious*, as implying, in addition to the hosts of imported aliens, a similar assistance to older 'indigenous' plants seeking new ground; or as the *conscious*, deliberate selection exercised in the cultural operations of agriculture, horticulture, and even forestry. It is sufficiently evident, that with *five* types of community, dominated by seasonal combinations of the *three* main biological determinants (temperature, light, and water-supply), together with the interaction of both natural and artificial selective agencies, the problem of sorting out the relationship of the present members of the flora becomes increasingly complex, and demands prolonged study. In any case seasonal periodicity, again as fundamentally affecting the activities of human agency, is the first thing to be considered.

The year is divided conventionally into four seasons, inherited like the Calendar from Roman civilization and the conditions of life in the Mediterranean region; and though these last follow the general features of the North Temperate Zone, they do not exactly correspond. The English spring bears little comparison with the corresponding season in S. Europe; the summer is however more tolerable, and the winter nearly as mild. It is more reasonable, botanically, to regard the seasons of the British climate as the response to varying combinations in the relations of temperature, water-supply, and light-intensity.

(1) During the early months of the year (Feb.–April) insolation is increasingly intensive, soil water-content is satisfactory; but the whole of plant-life is held up by failure in the *temperature*-relations. The flora may lose a working month in the year by a late spring, and it is at this time of the year that any residual strays of a colder climate may have the advantage.

(2) After Midsummer, with light at optimum intensity, and a higher range of temperature implying elimination of night-frosts, the *water*-problem becomes insistent, and scope is afforded for a xerophytic vegetation as importations from Central and Southern Europe; while aquatics attain their maximum development in river and ditch.

(3) Later in the year, with lowered temperature, but sufficiently retained water-content, the flora fails from diminishing *light*-intensity, to close down wholly in the winter months, in which light is wanting, temperature greatly reduced, and the water-supply in danger of freezing.

Only in the latter part of May and throughout June are all the three conditions sufficiently favourable for active vegetative growth, and the main stock of the indigenous herbaceous flora is thus predominantly geared to run its course in such a short season; as represented more particularly by the flowering and fruiting of the grasses of the Hay-crop and their associates.

Such generalizations serve to draw attention to the fact that the relations of the flora to the annual periodicity and changes of season are not of universal application, but are entirely a matter of the astronomical relation of this part of the Earth to the Sun, as expressed more particularly in phenomena of latitude. The latitude of Oxford is $51^{\circ} 46' N.$, and the duration of the year is taken in its conventional application.

All organisms on the world's surface, with a few unimportant exceptions, as in volcanic districts, live solely in virtue of light and heat derived from the sun. This is obvious in the case of autotrophic plant-life working in terms of light, but it applies equally to temperature. Any postulated internal heat of the globe has no effect at the surface; once the sun is withdrawn, as in the Arctic night, all fresh-water freezes, and plant-life closes down. That is to say the sun remains the causal factor in determining the annual succession.

To early man of tropical forest-land, or open country, the approximate division of the day into equal hours of light and darkness was an obvious factor of his existence. The sun was a thing to be avoided by day; but the moon, with its remarkable phases 'ruling the night', was the regulator of any perception of time beyond the actual days,—giving the month, the fortnight (from new moon to full, or the converse), and the week, as the time to the half (neutral) moon, as convenient natural divisions: in fact no other could be obtained.

But in northern extra-tropical lands, in which the sun was more clearly recognized as the giver of all life, and the only thing worth worshipping, the behaviour of the sun is more obviously followed. The peculiarities of its rising and setting at different points on the horizon, and its culmination at noon at different altitudes,—as giving readily observed solstices and equinoxes which there was no escaping,—became matters of essential importance in the working life of agricultural peoples now tied to seasons. As the annual period of the sun controls the sowing of annual crops, times of sowing require to be regulated by the sun; and hence observation of its declination, or points of rising, became significant in early astronomy; such observations being readily made without very elaborate instruments, when one minute of time in the increasing or decreasing length of the day is associated with a distance of about half the diameter of the sun's disk in its points of rising or setting.¹

Measures of time thus follow the *day* as a function of the earth, the *month* as a function of the moon, and the *year* as a function of the sun: but as these have no precise relation to one another, the modern Calendar is somewhat arbitrary; the months being now so conventional that their connexion with the moon is lost.² Again as the annual period of the sun becomes the great outstanding factor of plant-life in the N. Temperate, so it controls all social and political phases of existence in that part of the world, to dominate the rest of it.

To a modern town-population, sleeping most of the night, or living by artificial light much of the year, and rarely seeing the sun rise, or even set, on the open horizon, the working machinery of the seasons by which plants live is less apparent, and often little realized. Plants have no need for sleep: they merely endure the hours of darkness at the expense of their own resources: the more prolonged the hours of insolation, relative to the hours of darkness, the greater their activities. That some do better than others necessarily follows; but normally all plants live to the limit of their light possibilities.³

While actual sunlight determines the primary mechanism in the life of the plant, and variations in temperature affect the rate of reaction, the amount of available water-supply remains the critical factor; since this is

¹ The apparent movement of the sun is 15° per hour, and the sun's disk subtends $\frac{1}{2}^\circ$.

² Cf. Whitaker's Almanack for the current year.

³ The year of older civilizations was 12 months, or 12 moons, of approximately $29\frac{1}{2}$ days, or 354 in all. As the error of such a solar year became obvious to agricultural people growing annual crops, it was corrected by adding a bit at the end of the year; or in more modern custom, following the habits of northern nations more dependent on the sun by day (than on the moon by night in deserts of Persia and Arabia), by adding bits to each month. The present sequence of the Roman months dates to 452 B.C., and the more modern Calendar was established by Julius Caesar, 46 B.C., for a year of $365\frac{1}{4}$ days, with Equinox at March 25.

This still gave an error of a day too much in 128 years; and minor alterations were made by Augustus and others. An emendation by Pope Gregory XIII (1582), omitting 10 days, was adopted by Catholic countries, but not in England until 1752, when the error was about 12 days, and 11 were omitted between Sept. 2 and Sept. 14. Countries of Eastern Europe corrected the error 1923.

Hence in comparing modern seasonal effects with civil and ecclesiastical data of medieval England, there is an error of about 10 days in the solar years. Established festivals as New Year, Christmas Day, May Day, Midsummer Day, e.g., were 10 days later in the season. Thus old Christmas Day was in the cold early weeks of January, May Day was nearer mid-May, Valentine's day nearer March 1, Midsummer Day really in the hot 'dog-days' of July, and the Harvest would now appear to be earlier. In comparing older estimates of crops and floras, a range of a fortnight becomes a convenient unit, and mid-month a better gauge than the first of the month.

not only more variable and largely independent of astronomical relations, but it is absolutely necessary for all plant-life, which in all essentials is still wholly aqueous.

In addition to the general effect of the essential factors, of water-supply, light, and temperature, on the succession of plant-life during the seasons of the year, which make up the sum of climatic relations, variations in their relative degree of operation may affect the plant output in successive years, and more particularly as they may affect the plant during the optimum growing period. Marked changes during the winter perennation-period have little effect; but every year presents its own climatic and meteorological problems; no two years in succession are alike, and the vagaries of the British climate as they affect the population and the crops are matters of general recognition and discussion. The effect of such variations on the indigenous flora is also well defined; hence observations on the annual succession require to be checked over several years, and compared with any available meteorological data.

I. Sunlight Records.

Taking the total hours in a calendar year as 8,760, about half this may be allowed for night-periods; the local data for hours of possible sunlight total 4,457 in an ordinary year, and 4,468 in Leap Year. The maximum hours of bright sunshine recorded in the year is 1,809.6 (1899), and the minimum 1,158.3 (1888); these working out at 40% and 26% respectively.¹ The average 1,472.6, again, represents 33% of the hours possible, or just $\frac{1}{3}$ of total time.

The average duration in each month, by neutralizing the chances of cloudy weather, fog, and rain, will reflect the annual period of the increasing or declining altitude of the sun; and monthly sums of total hours will do the same. Tabulated figures give the total average of hours registered as 'bright sunlight', and the average number of hours per day in each month,² for comparison with the corresponding number of hours of daylight, and the maximum possible on the 21st of each month. Since, again, as in the case of temperature, the average is of less biological interest than the extremes, it is also useful to tabulate the maximum totals of hours of bright sunshine recorded in each month, as also the minimum, over as extended a period as possible. The maximum number of hours of bright sunshine recorded for any one day of the month may be similarly illustrated, the minimum being clearly 0 for all.

By taking the means of 40 years, the chances of weather are largely eliminated, and the curve reflects very approximately the annual period of the sun's altitude. But by expressing the hours of bright sunshine as percentages of the total hours of possible daylight, it will be seen that these, as also the complementary hours of dull weather, vary to some extent throughout the year: dull weather being at a maximum in the winter months, though the general year's average is 33% sunny and 67% cloud. Summer hours are just twice as sunny as those of winter:

¹ The brilliantly sunny summer of 1921 falls within this range (1,753.7, the next best) as does also the wet cloudy summer of 1922.

² Radcliffe Observatory Records, LII, p. 113.

The Radcliffe Records (40 years) run from 1880. They are taken by a Campbell-Stokes sunshine recorder, erected on the top of the tower, 116 ft. above the level of the Second Terrace, and represent an uninterrupted exposure from sunrise to sunset; i.e., under conditions much better than any possible exposure for local plant-life. The record is calculated from burnt strips; i.e., a weak sun, as often half an hour after sunrise or before sunset, is not included as 'bright' sunshine. In extreme cases (Nov. Dec.) no 'bright sunshine' may be recorded for 7 days in succession.

the sun is above the horizon at Midsummer twice the time it is in Midwinter; in summer days the record of sunny hours is four times that of the winter months, and the sun is approximately twice as powerful¹. The cloud average in the summer months is very uniformly 60 % of day time.

Table of Hours of Bright Sunshine.

	Total Hours of Sunlight.	Max. Hours of Bright Sunshine for month.	Min. Hours of Bright Sunshine for month.	Average (mean of 40 years) Total for month.	Percentage of Bright Sunshine for month.	Percentage of cloud and dull light for month.	Maximum for one day Bright Sunshine.	Average for one day Bright Sunshine.	Bright Sunshine Hours possible on the 21st.	
Jan. . .	257	76.6	14.9	50.9	19.8	80.2	7.85	1.64	8.41	Jan.
Feb. . .	276	105.6	29.9	67.5	24.5	75.5	9.15	2.39	10.26	Feb.
March . .	366	185.3	73.2	108.5	29.6	70.4	11.55	3.50	12.16	Mar.
April . .	414	252.8	84.2	151.4	36.5	63.4	13.80	5.05	14.16	Apr.
May . . .	482	293.6	119.8	193.3	40.1	59.9	15.15	6.23	15.81	May
June . .	496	252.4	130.0	192.6	38.8	61.2	15.60	6.42	16.55	June
July . .	499	310.4	99.2	190.0	38.1	61.9	15.50	6.13	15.87	July
August .	451	250.3	97.7	176.5	38.9	61.1	13.90	5.69	14.22	Aug.
Sept. . .	379	222.6	88.3	141.4	37.3	62.7	12.85	4.71	12.25	Sept.
Oct. . .	330	132.4	49.6	98.1	29.7	70.7	9.95	3.16	10.30	Oct.
Nov. . .	265	90.6	29.7	59.6	22.5	77.5	8.20	1.99	8.53	Nov.
Dec. . .	242	58.8	5.0	42.8	17.7	82.8	6.80	1.38	7.76	Dec.

Data for the altitude of the sun at noon may be taken from almanacs for the year (Whitaker), by which they may be computed for each day from tables of the Declination of the sun at Greenwich. The altitudes of the sun at apparent noon (Local Sundial Time) are obtained directly by adding to the quantities tabulated the co-latitude (for Oxford $90^{\circ}-51^{\circ}46' = 38^{\circ}14'$); south declination being considered negative.

Such data vary somewhat from year to year, owing to the length of the civil year being taken as 365 days, and local figures² are tabulated for

¹ The effective radiation-intensity of bright sunshine also varies considerably with the altitude of the sun; in general increasing with the altitude, though reduced by dust or haze in the atmosphere; as also according to the amount of water-vapour, which increases with the temperature. A small variation due to the earth's solar distance gives an increase of 7% in January more than in July. As the water-vapour content increases at about the same time as the earth's solar distance increases, the radiation intensity of the sun is greater in winter than in summer, and in early spring than in late autumn for the same altitude: monthly means again help in eliminating minor changes from day to day.

² These data are computed for N. Lat. 52° by Mr. H. H. Scott Barrett of the Radcliffe Observatory: the error introduced by the latitude (taken as 52° instead of $51^{\circ}46'$) will amount to a maximum at noon, when the amount tabulated will be too small by $15'$ (or $\frac{1}{4}$ degree, half the sun's diameter): but this will only be of the same order as the errors introduced by applying them to a mean year.

Local time is about 5 minutes later than Greenwich time, and 'summer-time' may have to be allowed for.

It will be noted that by taking means for intermediate weeks, this table gives very approximately

the 1st and 15th day of each month, with successive hour variations before (a.m.) and after noon (p.m.). From these tables it will be seen that the altitude of the sun is below 15° at Midwinter, and over 60° at Midsummer, or some 4 times the former. The radiation-intensity, however, does not increase to the same extent; the sun values for a surface at right angles to the rays being in summer approximately twice that of winter, as estimated in heat units (calories), or in illuminative action (candle power).¹

Table of Sun Altitudes for Lat. 52° .²

	12 noon	11 a.m. 1 p.m.	10 a.m. 2 p.m.	9 a.m. 3 p.m.	8 a.m. 4 p.m.	7 a.m. 5 p.m.	6 a.m. 6 p.m.	5 a.m. 7 p.m.	4 a.m. 8 p.m.	3 a.m. 9 p.m.
Jan. 1 . .	14.9	13.8	10.4	5.2	-1.5					
Jan. 15 . .	16.8	15.6	12.3	7.0	0.1	-7.8				
Feb. 1 . .	20.7	19.5	15.9	10.5	3.4	-4.7				
Feb. 15 . .	25.1	23.8	20.1	14.4	7.1	-1.2				
March 1 . .	30.2	28.8	24.9	18.9	11.4	2.9	-6.1			
March 15 . .	35.7	34.2	30.1	23.8	16.0	7.3	-1.8			
April 1 . .	42.4	40.8	36.3	29.6	21.6	12.7	3.5	-5.7		
April 15 . .	47.6	45.9	41.1	34.1	25.8	16.8	7.6	-1.5		
May 1 . .	53.0	51.1	46.0	38.6	30.1	21.0	11.8	2.9	-5.4	
May 15 . .	56.7	54.7	49.2	41.7	33.0	23.8	14.6	5.8	-2.2	
June 1 . .	60.0	57.8	52.1	44.3	35.5	26.3	17.2	8.5	0.6	-6.2
June 15 . .	61.3	59.1	53.3	45.4	36.5	27.3	18.2	9.5	1.7	-5.1
July 1 . .	61.1	58.9	53.1	45.2	36.3	27.1	18.0	9.4	1.5	-5.2
July 15 . .	59.6	57.4	51.8	44.0	35.2	26.0	16.9	8.2	0.2	-6.6
Aug. 1 . .	56.2	54.2	48.8	41.3	32.6	23.4	14.2	5.4	-2.7	
Aug. 15 . .	52.2	50.3	45.2	38.0	29.5	20.4	11.1	2.2	-6.0	
Sept. 1 . .	46.5	44.8	40.1	33.2	24.9	15.9	6.7	-2.4		
Sept. 15 . .	41.2	39.6	35.2	28.6	20.6	11.7	2.5	-6.6		
Oct. 1 . .	35.0	33.5	29.4	23.2	15.4	6.8	-2.4			
Oct. 15 . .	29.6	28.2	24.3	18.4	10.9	2.4	-6.6			
Nov. 1 . .	23.7	22.4	18.8	13.1	6.0	-2.3				
Nov. 15 . .	19.6	18.4	14.9	9.5	2.5	-5.6				
Dec. 1 . .	16.3	15.1	11.8	6.5	-0.3					
Dec. 15 . .	14.7	13.6	10.3	5.1	-1.7					

the altitude of the sun at any hour of the day throughout the year. The apex of the curve is June 21.

The quantities in this table [also more readily grasped in the form of a table of curves (Fig. 1)] are useful as expressing the approximate relations of the early and late hours of summer months with the maxima of the winter period. Thus the altitude of the sun at midwinter is comparable with that of the midsummer sun at 6 p.m., or at 4 p.m. at the equinox.

¹ Cf. Kimball, *Monthly Weather Review*, U. S. America, Nov. 1919, for data by Pyroheliometer, in grammes calories per sq. cm. per min.

loc. cit. (1922), p. 622, for similar data and curves in candle power for illuminative efficiency (total solar and sky illumination).

² Add 5 minutes for Greenwich time, and another hour for 'summer-time'.

'Summer-Time', a development of post-war years, interesting as indicating how an urban industrial population, working on a time-schedule arranged for the darker half of the year and ignoring plant-life, overrules the social regulation of the life of an agricultural minority, which has worked in terms of the sun's period and associated plant-life for over a thousand years. At the present time only about 12% of the working population are engaged on the land. The duration of summer-time followed:—1920, March 28–Oct. 25, 30 weeks; 1921, April 3–Oct. 2, 26 weeks; 1922, March 26–Oct. 8, 28 weeks; 1923, April 22–Sept. 16, 21 weeks; 1924, April 13–Sept. 21, 23 weeks.

Consideration of the amount of light received by the leaves of plants, horizontal, or inclined at various angles, and the plants themselves growing on level or sloping ground, becomes increasingly complex; but beyond a few general principles, it is clear that the existence of the plant is itself the best indication of a successful compromise between many distinct climatic and astronomical factors of sun and shade, quite apart from secondary shading effects of mutual competition and accidents of the station.

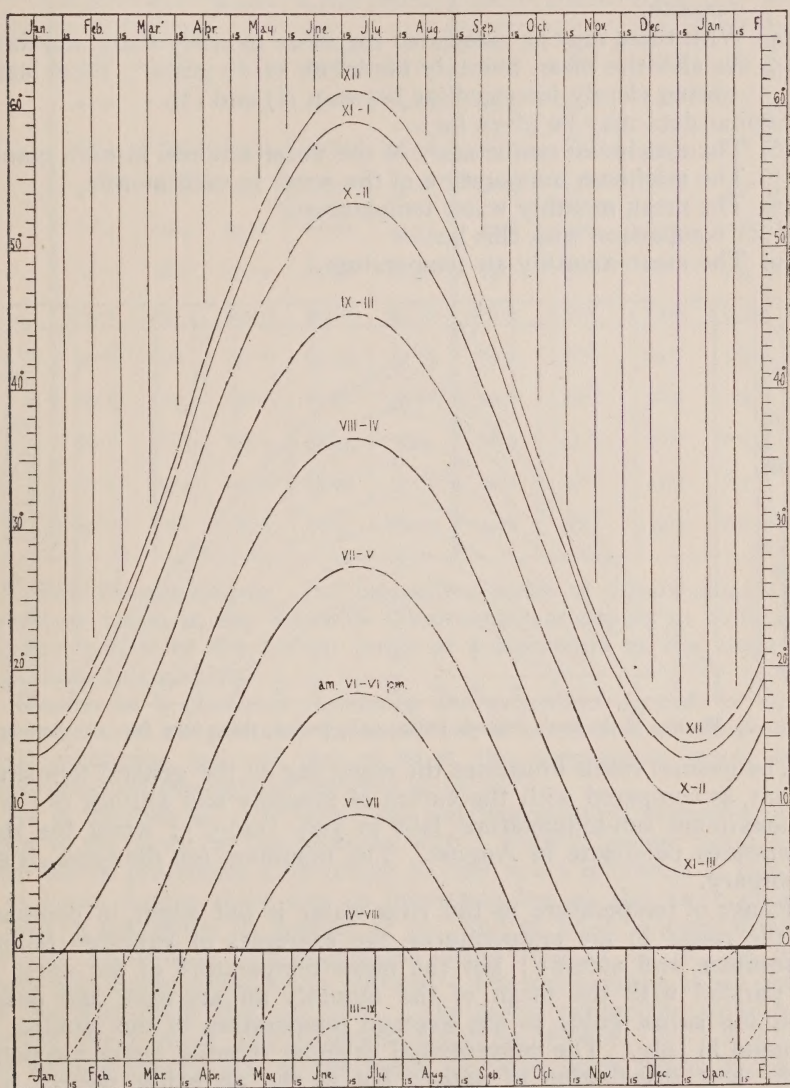


FIG. 1. Plotting of Sun Altitudes for Lat. 52° N., at successive hours of the day from Jan. to Jan.

2. Range of Annual Temperature.

Records of temperature variations are readily checked by thermometers, and are thus the first, as also the data most exhaustively taken in meteorological investigation. The records of the Radcliffe Observatory

extend for 70 years, and the annual curves may be readily constructed. In this case, again, special interest attaches, not so much to the average means, as to the maximum, minimum, and included range.

Scheduled figures are given for:—

- (1) Maximum recorded shade temperatures in every month.¹
- (2) Minimum recorded temperatures in every month on the open grass, hence usually by night.²
- (3) The maximum recorded temperature in open sunshine for each month.
- (4) With these may be associated the mean monthly shade maximum.³
- (5) As also the mean monthly minimum of 70 years⁴: these last two being clearly intermediate between (1) and (2).

Similar data may be given for:—

- (6) The maximum temperature of the water attained in each month.⁵
 - (7) The minimum temperature of the water in each month.
 - (8) The mean monthly water temperature.⁶
- and for comparison with this last—
- (9) The mean monthly air temperature.⁷

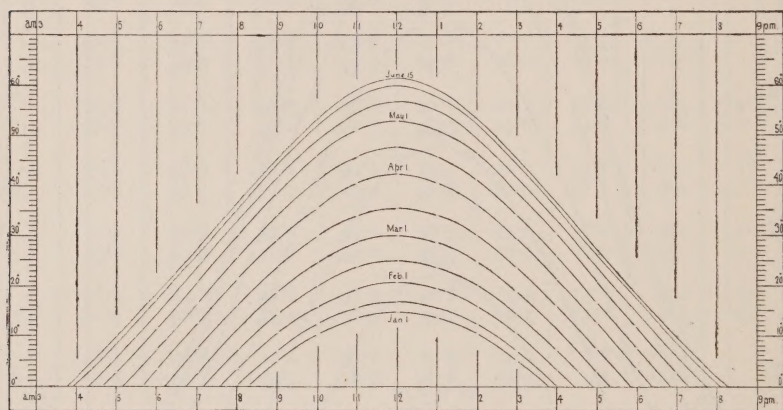


FIG. 2. Plotting of the Sun's Altitude for the daily period, rising from Jan. 1 to June 15.

The general result illustrates the slight lag on the general temperature relations, as compared with the curves of intensity and altitude of the sun. The maximum sun-temperature falls in July (149.5°); while the shade-temperatures culminate in August. The minimum (on the grass) is given in February.

Range of temperature in the river-water is but slight, in comparison with the range in air temperatures, the extremes of variation falling in late summer and autumn; but the mean temperature of the water runs very parallel with the mean of the monthly air averages, and possibly affords the surest guide to the average temperature of the months, with maximum in July. The conventional calendar months, again, are perhaps not the best distribution of dates; but as the accessible records follow these months they are obligatory.

¹ Radcliffe Observatory Reports, XLVII, p. 65; 69 years, LI, p. 209; LII, p. 102.

² loc. cit., LII, p. 105.

³ loc. cit., LII, p. 107, mean of 70 years.

⁴ loc. cit., LII, p. 109.

⁵ Data for Cherwell at Botanic Garden, J. J. Manley, Daubeny Laboratory Reports, Magdalen College, for 10 years (1914-1923).

⁶ J. J. Manley, loc. cit.

⁷ Radcliffe Observatory Reports, LI, LII, for Observatory Grounds (sheltered on Terrace Gravel); LI, p. 207, mean of 61 years.

Table of Air and Water Temperatures (degrees Fahrenheit).

	(1) Max. Shade Temp.	(2) Min. Temp.	(3) Max. Sun Temp.	(4) Mean Monthly Max.	(5) Mean Monthly Min.	(6) Cherwell Max. Temp.	(7) Cherwell Min. Temp.	(8) Cherwell Mean Temp.	Range.	(9) Mean Air Temp.
Jan. . .	56.7	2.5	97	43.46	34.37	44.3	36.4	39.3	7.9	38.65
Feb. . .	61.0	-2.7	109.3	45.17	34.73	43.5	34.8	40.0	8.7	39.81
March. .	66.2	9.9	125.9	48.92	35.48	46.4	38.7	42.8	7.7	41.79
April . .	77.8	16.4	131	55.51	39.13	52.5	45.0	48.0	7.5	46.99
May . .	82.4	20.4	139.2	61.80	44.11	59.8	54.2	57.5	5.6	52.46
June . .	87.2	26.8	146.4	67.56	50.01	65.1	57.8	62.2	7.3	58.51
July . .	89.2	32	149.5	70.67	53.28	68.5	60.0	63.8	8.5	61.58
Aug. . .	92.6	30	141.1	69.55	52.87	65.0	60.1	63.1	4.9	60.74
Sept. . .	89.2	24	136.7	64.71	48.88	59.6	56.7	58.0	2.9	56.38
Oct. . .	72.1	16.2	127.4	56.41	43.5	56.2	45.8	50.6	10.4	49.53
Nov. . .	61.1	13.4	109.6	48.43	37.76	45.2	38.7	42.7	6.5	43.00
Dec. . .	57.0	4.7	96.2	44.51	35.25	44.9	36.2	39.9	8.7	39.91

3. **Soil Temperatures.** An interesting series of observations on soil temperature, taken at the Radcliffe Observatory, at depths to 10 ft., afford a suggestive view of the annual range of temperature at the levels more accessible to tree-growth.¹

Records of 5 platinum resistance thermometers agreed in showing that the curve of temperature flattened out at successive depths, with the general conclusion deduced that at 66 ft. the temperature would remain sensibly constant throughout the year at 51° F.²

As in the case of river water, the soil temperatures present a definite relation to the mean air temperature, with a slightly greater range for the surface layers, presenting a maximum in July, and a minimum in February. But at lower depths there was an increasing lag on the curve, giving at 5 ft. 8 in. a maximum in August at 59°, and at 10 ft. a lower maximum (55.8°) in September; the suggestion being that at 28 ft. the further reduced maximum would fall in January. The entire range of the observations extended from 38.5° to 65.6°. The layers nearer the surface show a marked rise in April, and a marked fall in September. At 1 ft. 6 in. the curve follows closely that of the mean air curve (with minor fluctuations eliminated.)

4. **Water-content.** As the rainfall of an average 26 in. per annum

¹ Radcliffe Observatory Reports, LI, p. 120.

² In this case the substratum was well-drained river-washed Terrace Gravel of calcareous nature, with a small admixture of quartz grains from the Lower Greensand, but no clay silt. Unfortunately the site selected was near a small subterranean stream, from which flood-water rose to 10 ft., checking further operations. As the gravel bank extends beyond the depth of 28 ft., and is quite dry in other parts (St. John's garden dry at 25 ft.), it would be interesting to have further confirmation.

does not show any special periodicity, being distributed very impartially throughout the year at about $2\frac{1}{2}$ inches a month—also with the chance of variations from practically nil to 4-5 inches in any month of the year—the factors determining the water-content of different soils are determined by temperature, wind, atmospheric humidity, and the drainage capacity of the

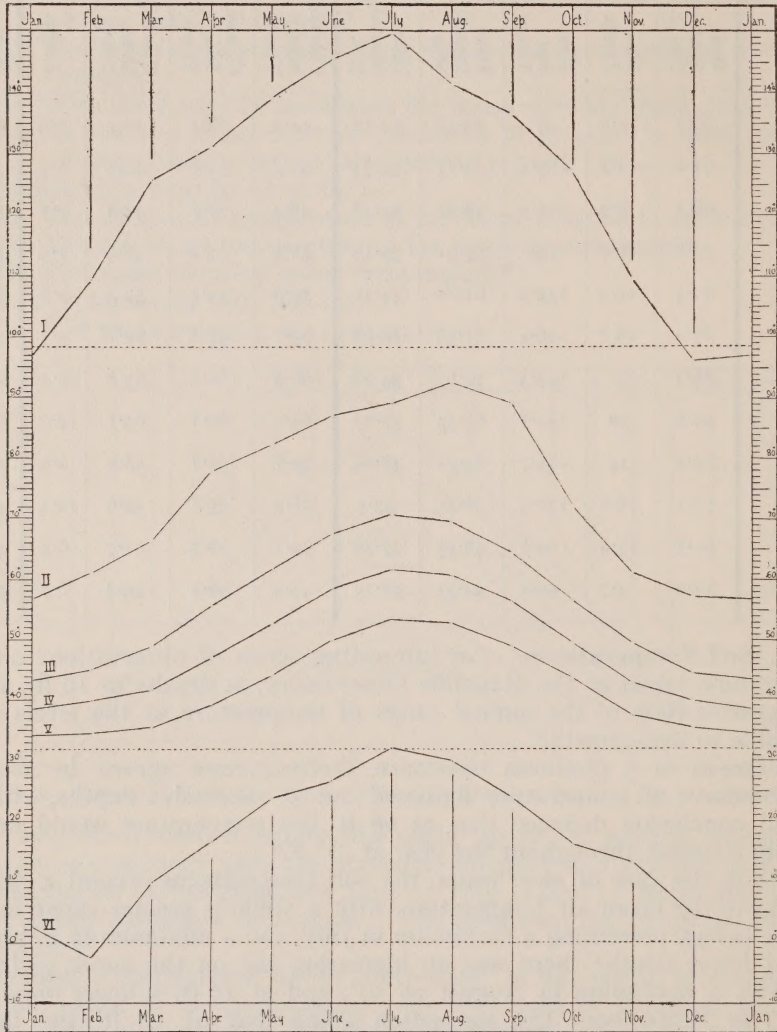


FIG. 3. Curves of Air Temperature throughout the year—

- I. Maximum temperature in sun.
- II. Maximum shade-temperature.
- III. Mean monthly maximum.
- IV. Mean annual temperature.
- V. Mean monthly minimum.
- VI. Minimum temperature on grass.

medium, as also its porosity and hygroscopic character in virtue of clay or humus content. So many factors are beyond simple analysis; but experience shows that the rainfall and associated capacity of the soil to retain moisture is at least sufficient to maintain tree-growth in all stations. Hence the case of too little water scarcely arises, though that of too much may become more insistent.

A special case is presented in the case of the flood-meadows, since the rivers (Isis and Cherwell) bring supplies from outside the district; any difficulty in controlling the flood action of these streams is thus due to extraneous rainfall. There is nothing to show that the fall within the area would be ever injurious, or beyond the capacity of local surface or subterranean streams to carry off. Miniature presentations of the formation of swamp-areas, in which minor surface streams are held up over clay by further accumulation of humus, are given in Bullingdon Bog and Headington Wick. The former is much reduced, the latter is little more than a wet gully-bottom. Cowley Marsh is drained as Golf Course, and a marsh only in name, as is also Littlemore, formerly a swampy tract fed by the Northfield Brook, the latter now deeply cut and free running.

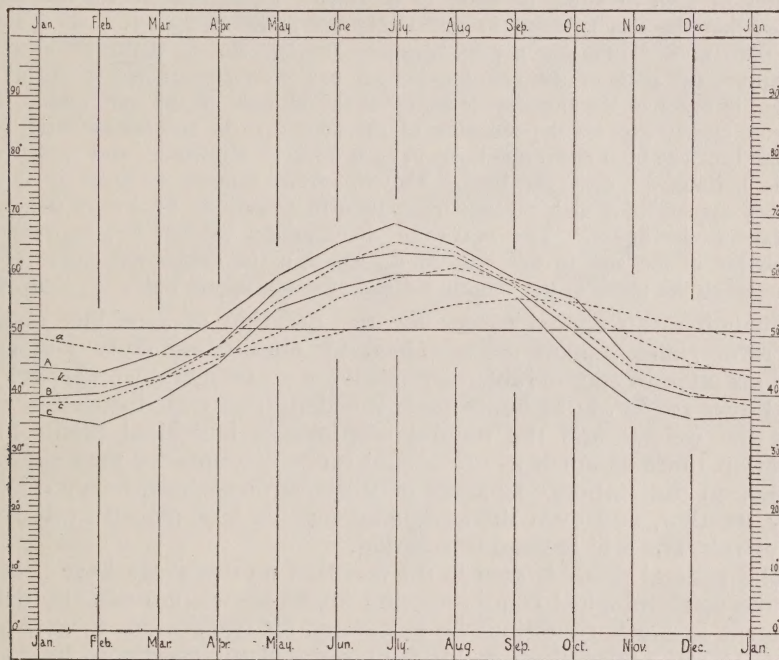


FIG. 4. Curves of Water and Soil Temperatures, Jan. to Jan.

- A. Maximum temperature of Cherwell.
- B. Mean temperature of Cherwell.
- C. Minimum temperature of Cherwell.
- a. Temperature of Soil at 10 ft.
- b. Temperature of Soil at 3 ft. 6 in.
- c. Temperature of Soil at 6 in.

Meteorological observations on temperature are qualitative rather than quantitative. The maxima and minima measured by thermometers afford no idea as to the duration of the recorded temperature. A momentary drop, for example, appears as marked on the register as a lengthy spell of many hours; and this applies to the evaluation of 'mean temperatures' from the same set of figures.

The curves may serve to visualize more clearly what is meant by a temperate climate. At no time of the year is the possibility of a drop to the frost-level wholly eliminated. The maximum shade-temperature is never above blood-heat (98.6°); yet the maximum sun-temperature in direct sun is usually above (only in December just under at 96.2°). It is thus curious to note that the winter sun (if one can only get it) can be warmer than

Midsummer shade (given, that is to say, shelter from cold wind in the former case, or from warm wind in the latter).

Records for water-temperatures and soil-temperatures give results clearly comparable. The average water-temperature runs very parallel with that of the soil at the depth of about a foot, and thus within the range of the roots of the great majority of herbaceous plants. Water-temperatures culminate in July; but there is a distinct lag in soil-temperatures in the deeper levels.

Three curves are given for water-temperatures—maximum, minimum, and the mean, for the Cherwell at the Botanic Garden; three curves for soil-temperatures taken from the Radcliffe records on Terrace Gravel, at $6\frac{1}{2}$ in., 3 ft. $6\frac{1}{2}$ in., and 9 ft. $11\frac{1}{2}$ in. respectively.

Curves plotted for the altitude of the sun at different times of the day and year, represent its position for noon and successive hours before and after (3 a.m. to noon, or noon to 9 p.m.). These hour-curves indicate the fact that the sun at noon in mid-December is lower than it is at 6 a.m. or 6 p.m. in mid-June (or 5 p.m. 'summer-time'). But as these curves do not express the path of the sun, another set has been constructed from the same data in order to visualize the changes in the altitude of the sun itself. These more clearly express the meaning of the facts that the sun rises at Midsummer *four* times as high above the horizon as it does in Midwinter, and is also above the horizon for *twice* the time. The rise from January to June 21 is again fairly approximate with the fall from June to December 21, within the error of drawing the figure. The curve for the Equinox (March 22) expresses the relation of the sun to this part of the world, if the earth's axis stood at right angles to the plane of the ecliptic instead of being tipped $23\frac{1}{2}^{\circ}$.

Though mean annual curves for the duration of sunshine, range of temperature, and rainfall are obtained by eliminating daily and casual variations often of considerable magnitude; e.g., temperature changes may extend over 100° F. in 24 hours; it is this daily and casual variation which affects the welfare and the mutual relations of individual plants in the association, quite as much as the annual range accounts for their continued existence in the station. Chances of frosts, strong winds, heavy rain, dull cloudy weather, and even drought, may involve any month in the year, without rule, and still beyond forecasting.

The general result is seen in the fact that no two years have precisely the same meteorological conditions, and for no association can any definite agreement in biotic conditions be postulated for two seasons in succession. That is to say, taking the general flora, some plants appear to be at their optimum in one summer, and others in the one following. In no station can constancy be guaranteed; quite apart from the even more insistent irregularity due to human interference in every department of the flora,—just as the fields of the agriculturalist present a systematic rotation of crops. The appearance of any specially predominant form, or floral display on the part of any particular species, may be taken to imply that it will not be necessarily repeated in the succeeding year in the same place, or at the same time.

Each year presents its own climatic individuality, following combinations of conditions of light-supply, temperature, and rainfall, which in the long run average up the conditions determining the primary constitution of the flora: but beyond this, each sub-department responds by a slightly different set of modifications in the output of its special flora. Such ringing the changes on the primary biotic factors is naturally most obvious where it occurs in the growing period of the year. As already indicated, the main seasons of the year are characterized by the lack of one or more of the essential requirements. Only in Spring (May, June) can all be said to be possibly present in an optimum condition. Hence secondary changes



3. *Petasites officinalis* ; Kennington, April 3, 1923.



4. *Caltha palustris* in Flood Meadow; Ifley, April 24, 1923.

within this special period become the next most significant determinants. Mean curves and averaged estimates are valuable in dealing with the appearance of plants and flowers in the annual succession, as they respond to the average of the years; but within the year, divergence from the mean may be considerable. Each secondary set of conditions evokes its respective dominants and sub-dominants, or latent forms,—the sub-dominants ready to take the place of the dominants, as soon as the conditions which may be the optimum for the latter begin to fail; as well as the vestigials, which in extreme cases may get a new lease of life, and so appear as sub-dominants. For example, a woodland may show little flower in the undergrowth; but as soon as the trees are cut down, letting in light on the woodland base, the clearings may become spectacular in blossom: grassland, if the conditions are at an optimum for the grass, gives few flowers; but if the rainfall be scanty in May, it may become gay with the blossoms of more deeply-rooted perennials; or, again, if too wet, with the free-flowering of sub-aquatics. A full crop of corn smothers its weed-flora; but when thin and scanty, the weed-bottom becomes the more gay with flowers; or in a wet season may even smother the crop, as clover may overgrow the Barley with which it was undersown. Even the river varies, with superabundance of submerged aquatics when the level is high, or is filled with flowering forms of the mud-banks when the water falls to any great extent in the summer months.

This great variety in possible combinations of biotic factors in the sub-floras, even in the different seasons of the same year, is, in fact, largely responsible for the great variety in plant-forms found in a small district. The balance of the flora is always shifting, not only in different years, but in every station, and at all seasons of the year. Whatever the apparent dominant of the moment, a large number of sub-dominants are continually biding their time. No set of conditions lasts for ever, and even vestigials are to be regarded as plants which have waited in vain for the times to change. Dominant oak-woodland, the limiting phase of local flora, cannot last for ever; with any opening up of the canopy, opportunity is given to herbaceous plants, long latent, to reassert themselves, and flower and fruit in abundance. Thus where older methods of forestry continue, utilizing Oak-standard and Coppice, many herbaceous plants survive the rotation of 10–20 years, vegetating in a depauperated and even non-flowering condition, but multiplying unchecked in the years of clearing, to be again diminished in the regeneration of the coppice. (*Scilla*, *Ajuga*, *Teucrium*, *Viola*, *Primula*, *Epilobium*, *Scabiosa*, *Sanicula*, *Arctium*, *Pteris*, &c.) Much of the phases of so-called succession are more clearly expressed as the *oscillatory effects* of uneven years. Even in the same season, daily and weekly changes in meteorological conditions work out a similar result. A week's heavy rain, a week's drought, severe frosts, or wind-storms, may at any time injuriously affect the dominants, and afford a chance for some of the sub-dominants to regain their footing. Each year and each month has its special climatic and meteorological problems, no two successive years being alike; or, in fact, any two whatever similar in detail. The minor vagaries of the climate as they affect the human population and its many crops or garden-produce, are commonly traced in the daily Press. The general effect on the indigenous flora is equally marked; and these plants, as presenting a wider biological range, may serve as more satisfactory indicators than the few forms found in agricultural practice to give fairly reliable crops, because they respond more evenly to the mean.

Seasonal changes in light-supply and temperature following astronomical conditions, being inevitable, occasion less remark; and these acting as

limiting factors in Autumn and Winter, close down the working flora to a perennating minimum. Minor and casual weather-variations affect the plant output the more as they occur in the growing season (May, June), or the period of general vegetation (March–September), and the results may be far-reaching. A cycle of four years has been taken as covering the more important of the possible biological combinations, in which one or more of the biotic factors is either wanting or excessive at different periods of the working year.¹ Even within such a short time it is possible to ring many changes on the factors of the succession.

Thus the season of **1921** was especially noteworthy for its shortage of water-supply, as presenting the year of greatest drought within living memory. After January there was little effective rain until Autumn, the year's rainfall being the lowest on record (15 in.). A dry Spring, with rainfall 3 inches below normal (Feb.–May), was succeeded by a dry summer, 5 inches below the average (June–August). All surface-water dried up, ditches ran dry, and vegetation was parched. Herbaceous plants flowered precociously from May onward, and want of rain was associated with excessive insolation (121 hours of bright sunshine above the normal in June and July). The Hay-crop was early; the Wheat-crop abundant, but Spring Barley a failure, and in many cases not worth cutting. The great drought emphasized the value of the water-meadows within the reach of irrigation from the river, even though the latter ran very low. The aquatic flora was particularly well-developed and striking. The Blackberry crop was remarkably abundant and early, and the effects of the drought could be traced for two succeeding years.

The summer of **1922**, on the other hand, was conspicuous for a long range of wet and dull cloudy weather, the greatest failure being in summer *light-supply* (July–Sept.). Early spring was favourable; but after a brief heat-spell in late May and the first week of June, there was no more summer weather for the year; the season being only a degree better than the 'sunless summer' of 1879; hours of bright sunshine were 133 below normal (July–Sept.), associated with 3 inches of rain above normal (July–Aug.). The summer was conspicuously late; the meadow hay was not cut until August. But following the extreme insolation of the previous year, spring blossoming had been exceptional on Sycamore, Ash, Beech, Oak, Hazel, and *Castanea*. Hedge Hawthorn had been spectacular, as also Bluebells of the woodland and Buttercups of the pastures. Spring-flowering trees followed with an exceptional fruiting-year: the masses of berries being phenomenal on Hawthorn and Sloe; but the Blackberry crop maturing in a wet July was a comparative failure.

The season of **1923** was again conspicuous for a failure from *low temperature* in the growing season of May and early June, though the later summer was good, and autumn normal. It may be termed 'a year without a spring'. After a brief spell of warmth in early May (75° May 4), a long period of cold winds (largely N.E.) set in, the temperature on May 28 being at best 50·4°, and on June 16, 56·1°. All plant forms were much delayed, many trees were not in full leaf till early June, some were even still bare in mid-June. Late June frosts killed Bracken in the open; the Hay-crop was poor, though the associated flowers were abundant. Summer xerophytes were much delayed; Apples only $\frac{1}{2}$ in. diam. by mid-June; Plums and Strawberries a failure. Also following extreme exhaustion of the previous year, there was no flower on Beech or Hornbeam, and only traces on Hazel, Oak, Sycamore, and Ash. Fruiting stages were even less; little on Hawthorn, and none on Sloe. The Blackberry crop was very late, with an optimum in October.

¹ The four years (1921–4) make up a fairly satisfactory set, and more than four does not seem requisite. It may be noted that this series does not include the effect of such extremes as (1) a heavy autumn flood, (2) a heavy Spring flood, (3) a long and severe frost-period, or (4) a heavy snowfall. The effects of flood have been largely minimized by attention to the river lock-system, and extremes of frost and snow falling within the dead, perennating period have little effect on the indigenous flora, though possibly fatal to many introduced exotics of human association.

From the human standpoint, 1924 presented a combination of failures, with a general effect of contrariness, commonly noticed in the English climate, as being 'unseasonable' at all times of the year. After a particularly mild January, there was a remarkable Spring drought (only $\frac{1}{2}$ inch rain in 7 weeks, February and March), and as a consequence the early spring floral display of woodland was extremely poor. Yet Easter Monday (April 21) was a brilliant summer-like day; though the first ideal May day was only reached on May 28 (the last day of Eights). Excessive rain in May and early June gave rise to a June flood which destroyed the chances of any special display by the aquatic summer flora; the hay-crop was luxuriant but remarkably poor in associated flowers. A short summer spell in early July was followed by a peculiarly showery and dull season throughout August and early September, greatly delaying both the Hay Harvest and Corn Harvest. This led to an early Autumn, continued as mild and predominantly wet for the rest of the year, with a temperature in mid-December closely approximating that of the previous mid-June, and heavy floods in the ensuing month.¹

In dealing with so complex a subject, involving multitudinous detail, difficulties arise in the adequate presentation of the matter in a short space: much of the facts may appear as the merest commonplace trivialities to residents in the district; but what is wanted is a picture of the whole, which may bear comparison with accounts of floristic phenomena in other parts of the world. In what can be no more than an introductory account, statistical tables and lengthy lists of plants, which constitute means of identification, are out of place, and, however interesting to the compiler, make tedious reading; just as the tables and means of the meteorologist often present a disappointing survey of weather-conditions. Where lists of plants are unavoidable, they are broken up as far as possible, for convenience of reference and textual recognition; but too great subdivision introduces confusion from overlapping. A bias in favour of flowering-stages is traditional with the botanist, as it also appeals to the aesthetic sense; and so long as conspicuous flowers afford the readiest means of identification, this also appears unavoidable; but it may be noted that the maximum photosynthetic work of the organism, on which its survival primarily depends, may be largely effected in the non-flowering stages. Similarly, the inclusion of plants, recognized in flower as occasional or casual, may add to the lists, and lead to an entirely exaggerated view of their ecological value. Hence lists are included as approximations, in forms as well as in locality and time, and are not exhaustive. The counting of individuals or blossoms on a given area, again, may be suggestive; but does not necessarily tell much of the relative vigour and dominance of the specimens; while starved plants may flower freely. Every method has its limitations and special errors. More detailed investigations may be tried out in critical cases, but are so far not essential to consideration of the general effect.

¹ This series of four years is particularly interesting as admitting a review of a special period immediately following the years of the war. During the latter period (1914-19), owing to depletion of labour, the countryside was much neglected, though there might be feverish activity in suburban allotment-cultivation and food-production. The woodlands were little tended, and allowed to grow wild, much pasture-land was let run to waste, and hedgerows were allowed to grow out and flourish unchecked. In this way the general effect of human interference was much reduced, with corresponding recovery of the wilder ecological plant-formations; so that in 1920 the condition of the local flora appeared much more hopeful than was warranted. Since 1920 human control has gradually resumed its sway; hedges have been extensively trimmed and cut down, willows pollarded, much waste recovered or cleaned up. The output of barbed wire is considerably increased, and exhortations to keep to foot-paths are more insistent. General progress, as expressed in building operations, the making of new roads, and the reconstruction of river-locks, carries on with redoubled energy. Consequent diminution of the available vestigia of the aboriginal flora necessarily follows. The present record thus comes at a critical stage in the history of the plant-life of the district; and whatever may be the fate of the latter, it may prove useful to have some standard of reference.

I. INTERGLACIAL INTERLUDES.

No better method of following the cycle of the annual succession of the local flora can be suggested than that of taking the sequence of the months, beginning with the New Year; not so much because the conventional calendar begins at the first of January, as that the Calendar itself has been evolved to follow the seasonal change, as this becomes insistent in the production of food-crops; the social and festive isolation of the New Year itself being the expression of the expectant renewal of plant-life consequent on the passing of the winter solstice.

From this date the steady increase of daily insolation, though slow at first, acts as a direct stimulus to plant-life. Though recurrent cold spells may be more severe than before Christmas, and repetition of cold waves may long delay any marked effect, new phenomena are rendered possible. Resting buds awaken to life; even if at first this may be more conspicuous in the introduced aliens of warmer climes in sheltered garden-cultivation.

Early spring-flowers and flowering shrubs have been intentionally introduced by so many generations from the time of the Roman occupation, and have become so familiar, that it is often difficult to realize that none of these are really indigenous; few are ever produced from seed; none have been successfully established; and where some remain apparently wild, they are only the strays of past cultivation, persisting in virtue of some successful perennation-habit, propagated vegetatively, and so far the direct continuation of the individuals of the original importation.

The winter of modern times commonly presents periods of mild open weather, alternating with spells of frost, usually of no great severity, and snowfalls usually small in amount, disappearing within a week. Only very exceptionally does the snow lie about for as much as 2-3 weeks, or a frost endure for as long as six weeks without a break. Exceptionally severe winters may be specially recorded; severe frosts (beyond 12 degrees (F.) of frost) are comparatively rare. The general average is mild, chilly, and damp, rather than severely cold and dry. Exceptional winters with continuous mild weather and practically no frost at all may be also recorded. Such mild seasons afford a maximum shade-temperature around 55° F., and nights with a minimum nearer 40° F.

At Dec. 21 the hours of possible sunshine are $7\frac{3}{4}$, and the sun at noon is less than 15° above the horizon. By January 15 the time is increased to $8\frac{1}{4}$; by the end of the month to 9; and by the end of February to just $10\frac{3}{4}$ hours a day, with the altitude of the sun at noon rising to 30°. In mild and open weather a distinct advance may be seen by the end of January; while the middle of February (Valentine's Day)¹ may afford a distinct suggestion of Spring. In severe seasons all such effects are delayed until late in March. Normally the approach of Winter is indicated by advancing colder waves as the days become shorter in autumn, and the onset of spring by the cold spells being spaced farther apart, and by their losing their severity as the sun gets stronger during the day. With the increasing insolation of the days after the vernal equinox, frosts gradually cease; though traces may persist as late as the middle of May, and even exceptionally in early June.

Between the colder spells, periods of temperate warmth may occur

¹ St. Valentine's Day is commonly associated with the maximum flowering in gardens of the Snowdrop and the Winter Aconite, and the first yellow Crocuses.

at any time in the darker months;¹ and these help one to visualize on a small scale the 'Interglacial' periods of the geologist. Such periods in Jan. and Feb. of spring-like temperature, differ only from the conditions of March and April in the reduced number of hours of daylight. These again, at a day range of 50°–55° F., and a night temperature above freezing point, encourage vegetation to follow on from the preceding autumn; while the perennation-period of spring-growths may be considerably abbreviated. Thus, hardy, much-enduring herbaceous perennials may continue to flower casually as the buds follow out their preceding developmental stages of the late autumn, the foliage-buds of deciduous trees enlarge and may break out into leaf, while the first definite flowers of the new season may come into bloom much earlier than usual. In such mild winters vegetation may be as advanced in early February, as in severe seasons it is at the end of March; implying a range of 6–8 weeks in the seasonal change.

By the end of January the days are distinctly lengthening and brightening, though it still gets dark at 5 p.m. The majority of woodland trees and plants are wholly at a standstill. Green mosses on the ground and grey lichens on the trees are more conspicuous, and contrast with the deep brown of the Bracken, by this time completely wrecked and broken down. The deep green of Ivy and planted Conifers contrasts with the residual brown foliage still met with on individual oaks, and more particularly in the case of Coppice Beech. The Brambles of the under-wood also show up green against the dead *Pteris*. Hazel catkins, elongating in December, shed pollen readily on a rise of temperature, and will do so indoors freely at Christmas, and in the open by Jan. 1. The older coppice trees give their optimum display by the end of the month. In sheltered gardens *Salix caprea* sheds the single bud-scale of its staminate catkins (Jan. 1), and all may be silvery by the middle of the month. Ivy-berries turn black, and the staminate flowers of *Taxus* are ready to shed pollen (Jan. 30). The foliage-buds of Siberian forms of Larch show the tips of green needles; feeble blossoms of the Primrose break out, and the flowers of *Ulex* become conspicuous in sheltered situations. *Alnus* catkins elongate, and shed their pollen on a rise of temperature (indoors by Jan. 15, in the open Jan. 30). *Viscum* staminate flowers break open (Jan. 20), and Common Elms show red tops against the blue sky as their inflorescence-buds enlarge and break out in flower (Jan. 25).

The first signs of returning vegetation are welcomed as relieving the prevailing gloom, decay, and mire of the countryside. In the fields the Wheat and autumn-sown crops (Barley, Oats, Beans) show a dense growth of foliage; the pastures are still perennating: fields grazed continuously by cattle may show green; but where left wholly ungrazed, the ground is still covered by a bleached mantle of the dead herbage of the previous autumn. New blossoms of the Daisy and Dandelion become increasingly numerous. In arable fields a small selection of aliens may be found flowering at any time during the winter months, as the hardiest weeds of cultivation, e.g., with Daisies and Dandelions:—

<i>Poa annua</i> ,	<i>Stellaria media</i> ,	<i>Lamium purpureum</i> ,
<i>Capsella Bursa-pastoris</i> ,	<i>Veronica Tournefortii</i> ,	<i>Senecio vulgaris</i> ,
<i>Senecio squalidus</i> ,	<i>Euphorbia Peplus</i> ,	<i>Euphorbia Helioscopia</i> .

All again are abundant in neglected allotment areas, and in sheltered positions along roadsides and waste places, with *Lamium album*, and on old walls, *Linaria Cymbalaria* and *Hieracium murorum*. Few of these

¹ Cf. Jan. 25–Feb. 4, 1924, 10 days with no rain or strong wind, mild sunny days more characteristic of March.

however set seed, and the majority are autogamous. Broad patches of *Lamium purpureum* in cultivated ground alone give any conspicuous floral effect, as the upper leaves of the flowering shoots grow purple in the sun. Such plants are so far merely the surviving vestiges of past autumn, or humanly assisted aliens persisting in sheltered spots, on a footing with garden forms.

Early flowering may be induced by rising temperature in new season's plants in which the mechanism of perennation is more definitely subterranean or at the soil-level, and the first blossoms are shot up in as yet depauperated form before the appearance of the maincrop. Such casual strays may be found at the end of January, much in advance of the normal flowering period: e.g.—*Mercurialis perennis*, with new foliage-shoots in sheltered woodland, the flowers appearing with the first green leaves (Jan. 20), together with *Viola Riviniana*, *Primula vulgaris*, *Anemone nemorosa*, as also *Ranunculus acris* and *Anthriscus sylvestris* in waste ground. All these may give similar results exceptionally in late autumn. To the more definitely new season belong:—

Caltha palustris (Jan. 25), *Tussilago Farfara* (Jan. 11), with *Draba verna* (Jan. 1), and *Ranunculus Ficaria* (Jan. 7).

From such phenomena it is clear that winter cold is not a necessity; there is no demand for a prolonged winter rest: spells of frost merely delay the normal sequence, and all plants would be better without it.

Much the same applies to the familiar winter flowers of garden-cultivation, many of which are to be regarded as delayed from a mild autumn rather than the expression of the new season's crop: cf. *Jasminum nudiflorum*, introduced from China, flowering from November on; *Viburnum Tinus* of the Mediterranean region, *Daphne Mezereum*, the Glastonbury Thorn (hence misnamed var. *praecox* of *Crataegus monogyna*), *Garrya elliptica* ♂ of California, *Chimonanthus fragrans* flowering on the bare wood, and also the Christmas Rose (*Helleborus niger*). These thus mingle with the first stray blossoms of the yellow *Crocus aureus* (Jan. 29), *Eranthis hyemalis*, and *Galanthus nivalis*, sending up their flowers from perennating corm, rhizome, or bulb, before the end of January in mild seasons, and even the first blossoms of *Forsythia Fortunei* (Jan. 2).¹

Where fruit has been abundant in the preceding autumn, large quantities of berries remain on the trees of underwood and in the hedgerows. Rose hips, Hawthorn berries, Privet, Holly, and blue Sloes, with Dogwood, Guelder Rose, and Spindle Tree berries, may show conspicuously in late January. The last are subject to decay by the action of rain and weather, but others persist well into the spring. Yellow crab-apples lie thickly on the ground beneath the trees into April; and Hawthorn bushes, remaining coral-red with fruit, present an effective contrast when the new leaves break out towards the end of March.²

Nor is aquatic vegetation wholly resting. Cleaned ditches with running water show a striking collection of actively photosynthetic shoots of submerged forms, as dense masses of fresh green foliage of such plants as *Callitriche verna*, *Elodea canadensis*, *Ranunculus circinatus*, *R. fluitans*, *Oenanthe fluviatilis*, and floating grass leaves of *Agrostis* and *Glyceria*, filling the water-courses with banks and masses several feet or yards in extent, but liable to be completely buried beneath flood-water.

In such mild seasons considerable advance is seen in early February, though the sun still sets beneath the western hills at 5 p.m. The maincrop of Hazel catkins (♂) may be over, though individual later trees

¹ Most of these dates refer to the particularly mild winters of 1921, 1923.

² These effects being conspicuous in 1923 as the result of the summer of 1921.

continue at an optimum. *Alnus* catkins (♂) are shedding freely, and the flowers of the Mistletoe are at their best. Common Elm and Huntingdon Elm may be in full bloom in the upper branches. *Taxus* is shedding pollen freely, and the first staminate catkins of *Salix caprea* break out (Feb. 11). *Ulex* comes into bloom *en masse* in sheltered situations. The earliest plants to break into leaf are the Elder and Honeysuckle of the underwood; though Weeping Willows may appear conspicuously green amongst other trees (Feb. 1). Many garden-shrubs may show leaf (*Weigelia*, *Buddleia variabilis*), and Lilac buds break out to disclose the terminal inflorescences. *Cydonia japonica* may give good flowers, *Prunus Pissardii* be whitened with bloom, and the buds of the Almond show pink. Indigenous herbaceous forms make little advance, but garden bulbs come on in force with the optimum crop of early Crocus and Snowdrops, as *Chionodoxa* (Feb. 12) and *Leucojum Hernandezii* (Feb. 8).

Such interglacial intervals are however subject to sudden suppression by periods of cold winds and severe frost. Water-courses may be hard frozen, and the *Caltha* fields covered with flood-water, and this again frozen and covered with snow; frost may even penetrate the shelter of the trees, and all early woodland forms may be severely checked. Rarely are such early open seasons continued on to the full spring recovery (1921), and a much later season with prolonged perennation-period gives more effective results, with recovery a month later in March. As optimum conditions of plant-growth will not come in any case before May, a cold spell delaying all perennating systems in Jan. and Feb. is better than a mild winter with cold spells in March and April. Such mild spells of climate in January and February affect more particularly garden-vegetation and introduced plants and shrubs, allowing them to bud freely, with every appearance of spring before their time. Subsequent spells of cold drying winds from N. and NE., associated more particularly with March, may delay these, and the regeneration of the maincrop of foliage buds is not readily repeated (Roses, Ramblers, Weeping Willow, Siberian Larch). Such plants may be badly checked, and a mild January and February is often regarded as a calamity. On the other hand, the indigenous trees of woodland show little change; they do not move so readily, or are hardy enough to resist it (Elder, Hawthorn, *Salix caprea*). Continued mild weather also implies the successful endurance of the winter period by vast numbers of insect-forms which might otherwise have been killed¹; and for this reason, as also that the vegetation thus brought on in mild damp weather will prove succulent and delicate in the event of later frosts beyond capacity for recovery, such winters are seldom regarded as a boon by the gardener or agriculturalist.

With the floral and insect-life of the countryside wholly closed down, opportunity is afforded for the examination of the lower, older, much-enduring types of vegetation, capable of existing with feeblest insolation, and at reduced temperature in damp sub-saturated air. Autotrophic plants of more nearly algal habit begin to assert their presence (Mosses, Hepaticae, Jungermanniaceae), together with Lichens and gelatinous Fungi. The great range of Moss-types of the woodland floor presents a special interest, as it alone remains to afford an idea of both the ecological habit and the biological conditions of the earliest land-gametophytes. The larger woodland mosses probably attain a development equal to that of the earliest prothallia of forest-forms; as conversely they may serve to

¹ Hibernating insects may emerge in mild spells; *Eristalis tenax*, Jan. 25; Queen Wasp, Jan. 25. Gnats may be seen at any time.

visualize in the same ecological formation phases of plant-life of a comparable horizon. Among the more conspicuous forms may be included ¹ :—

On leaf-mould in permanently wet shady bottoms :—

Sphagnum cymbifolium, *Plagiothecium denticulatum*.

In damp woodland bottom :—

<i>Catharinea undulata</i> ,	<i>Mnium hornum</i> ,	<i>Mnium undulatum</i> ,
<i>Neckera complanata</i> ,	<i>Hypnum molluscum</i> ,	<i>Hylocomium splendens</i> ,
<i>Thuidium tamariscinium</i> ,	<i>Eurhynchium striatum</i> ,	<i>Eurhynchium praelongum</i> ,
<i>Brachythecium rutabulum</i> .		

In open woodland with grass :—

Brachythecium purum, *Hypnum Schreberi*, *Hypnum cupressiforme*,
Hylocomium squarrosum.

In sub-calcareous woodland bottom :—

Hylocomium triquetrum, *Porotrichum alopecurum*.

On clay woodland bottom :—

Fissidens taxifolius.

Covering expanses of bare ground in open clearings :—

Dicranella heteromalla (f.), *Bryum argenteum* (f.), *Polytrichum formosum* (f.),
Campylopus pyriformis, *Ceratodon purpureus* (f.).

On Oak-stools :—

Isoetecium myurum, *Eurhynchium myosuroides*, *Hypnum cupressiforme* (esp.
var. *filiforme*).

On open fire-sites :—

Funaria hygrometrica.

In dry Oak coppice :—

Leucobryum glaucum, *Dicranum scoparium*, *Dicranoweisia cirrhata*.

The list is limited to 30 forms, as including the commoner and more conspicuous mosses of Bagley Wood. The collector's list may be readily extended; but this may suffice to indicate that many species are restricted to special ecological stations, determined by factors of water-supply, shade, and soil acidity. All shade-forms are conspicuously sterile; the few forms commonly producing capsules are indicated by the letter (f.).

Conditions for moss-growth in Bagley Wood are distinctly unfavourable, owing to chances of extreme desiccation of the clay and gravel soils in hot summer. The list includes several forms of special Botanical interest: the most beautiful fern-like frondose type is *Thuidium tamariscinium*, closely approached by *Hylocomium splendens*; *Mnium undulatum* and *Porotrichum alopecurum* have an elegant dendroid habit; *Sphagnum* is now merely vestigial; *Campylopus* is conspicuously 'fragile': *Funaria*, on fire-sites, grows in densely fruiting patches, 4-5 ft. diameter: *Leucobryum*, a large tufted moss growing only in oak-coppice, has been lost when the coppice is cut, but reappears on the regeneration of the canopy.

Hepaticae are feebly represented ² :—

On soil :—

Pellia epiphylla (f.), humicolous, in damp bottoms,
Marchantia polymorpha (f.), calcicolous, on forest-paths.

On mud of stream-sides :—

Fegatella conica.

¹ Nomenclature follows Dixon (1896), Student's Handbook of British Mosses; identifications have been checked by Mr. A. Gepp. The detailed collector's list for the County of Oxford, drawn up by H. Boswell, is given in Druce's Flora of Oxfordshire (1886), p. 404, as including Mosses 194 sp., Hepaticae 26 sp. A later revision, from herbarium-material (1921, Proc. Ashmolean Nat. Hist. Soc., p. 25) gives 215 mosses and 31 liverworts.

² The majority sterile, and all in very small quantity.

On bark of trees (Hazel) in damp bottoms only:—

Frullania dilatata, *Frullania tamarisci*.

Among moss in damp shaded woodland base:—

Lophocolea bidentata, *Plagiochila asplenoides*.

In damp winter months, when the leaves are off the trees, the Lichen-flora also becomes more conspicuous and interesting in lack of other plant-life. As common forms of woodland may be included¹:—

On open ground:—

Peltigera canina, *Cladonia sylvatica*, *Cladonia pyxidata*,
P. rufescens, var. *praeextata*, *Cladonia furcata*, *Cladonia fimbriata*.

Also extending to the base of tree-trunks:—

Peltigera rufescens, *Cladonia squamosa*, *Cladonia macilentia*.

On old Oak-trunks and branches:—

Calicium hyperellum, *Parmelia physodes*, *Evernia prunastri*,
Pertusaria faginea, *Parmelia caperata*, *Ramalina farinacea*,
Pertusaria pertusa, *Usnea florida*.

On Coppice-Oak:—

Parmelia fuliginosa (var. *laetevirens*).

On Alder and Hazel in damp bottoms:—

Graphis elegans (f.), *Graphis scripta* (f.).

On close-planted Coppice-Larch, Birch, Sycamore:—

Lecanora varia (f.), *Lecanora sub-fusca*, var. *chlarona* (f.).

The majority of forms are sorediate only. Old branches of Oak-coppice are clothed in *Evernia prunastri* and *Parmelia physodes*. *Parmelia caperata* forms conspicuous pale patches on Oaks, to 6–10 inches in diameter. White mealy dusty spots on Oaks (*Pertusaria faginea*), yellow dust (*Calicium hyperellum*), and greenish-grey dust (*Lecanora varia*, on Coppice-Larch), are also conspicuous. *Usnea* is remarkably scanty; *Cladonia coccifera* is now extinct, and other forms are present in no great quantity.

Heterotrophic forms as Fungi, conspicuous and general in woodland (Bagley) in mild winter months, include *Auricularia* (*Hirneola Auri-Judae*) on old Elder stems in Coppice growth; *Tremella aurantiaca*, as bright orange masses on Coppice-Oak: *Rhytisma acerinum* on drifted leaves of Sycamore. Agaricineae and Puff-Balls are destroyed by the weather.

¹ The list is conveniently restricted to 20 forms in Bagley Wood: nomenclature follows Lorrain-Smith (1918) Monograph of British Lichens; identification has been checked by Miss A. Lorrain-Smith.

II. THE BEGINNING OF SPRING.

The reawakening of plant and subordinate animal life in the spring months admittedly constitutes the most striking biological feature of the North Temperate Zone, and in this district with no permanent snow-mantle, the effects are quite as significant as in localities with a more severe or 'continental' winter, though the change may not be so spectacular, and is often subject to a prolonged period of marking time. Instead of the sudden disappearance of the winter's snow under an intense sun with a mild wind, and the almost immediate reclothing of the face of the land with a green flush of vegetation, the spring of Mid-England is apt to drag out over a period of 6-8 weeks, with a chance of exposure to the desiccation of cold winds, and little appreciable change from day to day, though the general result is none the less sure and effective.

Temperature-relations in March show little though steady advance on those of the previous month. The mean average air-temperature is only 4 degrees higher, and the mean minimum about one degree higher. An average year gives the mean air-temperature 41.79°F. ; the average maximum in the sun about 100° (max. 109.3°), with occasional range on warm days to 125.9° . The minimum on the grass averages 18.7° , still well below the frost-line, dropping occasionally to severe frosts of over 20 degrees (to 9.9°). The river-temperature ranges from 38° to 46° .

On the other hand, the light-supply is gaining rapidly in intensity and duration to the vernal equinox with 12 hours daylight; though the hours registered as 'bright sunshine' may only average 3-4 per day (average total hours in March, 108.5). At the vernal equinox (March 21st), which fixes the conventional date for the beginning of spring, the hours of possible daylight begin once more to counterbalance the night period; and with the sun rising over 38° at noon, the increasing intensity of the light compensates for the slower rise of the curve of average temperature. At 3.50 p.m., the sunset time of Midwinter, the sun is still higher in the sky than it was at noon on the shortest day. Plant-life begins to stir and show signs of progress in stations in which there has been for some months practically no visible growth of any kind; as after three months of winter wreckage the existence of a flora makes itself felt once more.

The few flowers so far observed remain largely in sheltered stations as the derelicts of the past autumn; and those which appear as the advance guard of the new season attract attention by their apparently exceptional behaviour. Insect-life is equally non-existent in woods and hedgerows: perennation and endurance of dark and cold being still the prevailing features on every hand. This has been seen to apply to the few hardy weeds of human association in fields and waste places throughout January, and the first flowers of February are of little better order. Though it is usual to regard the Winter Aconite (*Eranthis*), the bulbous Snowdrop, and the first yellow Crocus as 'spring flowers', these are not indigenous, but the introduced vegetation of a southern climate, in which the mild winter is more favourable for plant-growth than the hot dry summer over which they have been accustomed to perennate. Hence such spring flowers appear rather as delayed products of the cool autumn, with the resting-period extended still later by the greater cold; as the Spring Crocuses are closely related to the autumn-flowering Saffron Crocus and *C. nudiflorus* of September, and the earliest Snowdrop of the Eastern Mediterranean (*Galanthus Elwesii*) may blossom well before Christmas in open seasons. Much the same applies to the first Hazel catkins (often well out by Jan. 1),

the flowering of the Alders in mid-February with the Mistletoe and *Taxus* as contemporaries of the Snowdrop. In these again there is no special bud-protection to the catkins or flowers; the flower-buds perennate 'naked', or practically so; hence, exposed on the branches to the warmth of the sun in mild periods, they open at any early date, just as they will do on being brought for a few days into a warm room.

Locally, the period of wreckage of the flora, included as the biological winter, runs very approximately for 3 months,—from the last leaf-fall (Nov. 15) to Feb. 15: the period of recovery from Feb. 15 to May 15, as another three months spell, represents the ecological spring. Taking the breaking of the winter-bud as the first sign of spring-rejuvenation, the exposure of the silvery catkin-buds of the Sallow (*Salix caprea* ♂), by the shedding of the single dark bud-scale, may be regarded as the first real suggestion of spring advance; and though in sheltered gardens this has been observed as early as Jan. 1, the phenomenon is not general in woodland until Feb. 15. In late February many leafy buds begin to swell and show the beginnings of green foliage; as in the case of the Elder, Hedge Plum (*Prunus insititia*), and Hawthorn. The inflorescence-buds of the Elm shed their protective scales in quantity beneath the trees, and the alien Weeping Willow is the first tree to come out in a green veil of young leaves. On some dull, wet day in mid-February, with mild rain and much mud, one becomes conscious, even in the town, that the year has after all turned: birds are singing, and some beginning their nests: the grass is distinctly greener: foliage-buds are swelling white and green, to break out in the hedges: the hedge-bottoms fill up with green foliage, and the first spring flowers begin to be general. Gardens are brightened by yellow and blue Crocuses, Rambler Roses are covered with green leafy shoots, buds break out on Privet, Hawthorn, Elder, Clematis, Laburnum, Lilac, to a new green growth on *Buddleia*, *Euonymus japonicus*; *Daphne Mezereum* and *Prunus insititia* are flowering on the bare branches.

In average seasons, where the early months of the year have continued mild and dry, with no long-continued frost-periods, these new departures may be well marked by the end of the month; and, at any rate, in the first week of March¹ a distinct change for the better may be observed, and Spring may be said to be so far on the way. Thus, under favourable conditions, the more characteristic spring-flowers begin to bloom; hibernated insects become noticeable, as early bees leave their hives on sunny days; birds become actively and even noisily vocal; fruit-trees begin to break out their buds, and perennating herbaceous forms send up abundance of fresh leafy shoots in underwood and hedges, though seedlings of annuals are largely residual from the autumn, and aquatic vegetation is at a standstill owing to the continued low temperature of the water (40° F.). Days of clear sky, keen winds, and dazzling sunshine are associated with the idea of March weather², as gloomy skies and driving rain are often associated with February when there is no frost-period. But these conditions are closely intermingled. Typical March days may occur in mid- or late February, or March may be prevailingly wet.³ Fine days of

¹ March 1 coincides approximately with the rowing of the Torpids; in 1895 the latter were omitted as the river was frozen, and for six weeks in Hilary Term the only sport discussed was skating.

² The strong draw of the wind through the leafless tops of the large trees, which added to the depression of winter storms, when now associated with blue sky and intense sunshine, appeals to the poetically minded as a revivifying force; but the full xerophytic effect of its desiccatory power is seen in the cracking of woody fir-cones, the opening of the dried pods of the Laburnum, and the shedding of needles of Pine and Cedar.

³ Record (1916) 5.179 inches rain. February (mean of 70 years) has the lowest rainfall-average of any month in the year (1.624 in.); but the wet lies about on a clay soil and there is little evaporation. Hence drying winds of March are much appreciated.

spring-like intensity may be followed by cold rain or drizzle. The combined effect on vegetation is very beneficial; the photosynthetic advance of the clear days being followed by the easing off of the desiccation-problem, as the buds swell and begin to leaf on herbaceous plants and shrubs long before much change is noticed in the trees of high forest. This again is only the expression of the fact that the larger and deep-rooted forms of forest-life are more securely graded to the mean changes of climate (Oak, Beech, Ash, Pine, Birch): smaller forms living in the underwood, with shallow roots, or the more recent importations of garden-cultivation, present a more active response to casual variations on the main curve of progression.

At the close of February the daylight still fails rapidly after 5.30 p.m. The woodland remains predominantly dormant. The flowering of the Hazel coppice is followed by that of the Alders, and the Common Elms (*Ulmus campestris*) in the hedgerows, all well before the leaves. The silvery staminate catkins of *Populus tremula* and *P. canescens* break out and are freely shed. Green half-grown *Mercurialis* shoots begin to tint sheltered bottoms of the underwood, with the first staminate flowers expanding: spotted Arum leaves push up, as also those of *Orchis mascula*, and the tufted leaves of *Scilla* appear in coppice and clearings. Sheltered hedgerows become green with new shoots of Nettle, *Galium Aparine*, *Alliaria*, *Anthriscus sylvestris*, *Lamium* and *Aegopodium*, as common weeds of human association. Arable fields and allotments continue to produce great quantities of the hardy ubiquitous weeds together with the first new flowering seedlings of *Capsella* (1 in.); as *Lamium purpureum*, *Senecio vulgaris*, *Stellaria media*, and *Veronica Tournefortii*, among the residual Cabbages and stumps of sprouting Broccoli. *Draba* shows white on old rag-stone walls (at even $\frac{1}{2}$ inch high). In the pastures there is no change. Apart from later alien introductions, the most characteristic flowers of the new season are perhaps the Celandine (*Ranunculus Ficaria*) of woodland clearings and hedgerows, the *Draba* of old walls, and *Tussilago Farfara* of sandy fields and waste, all continuing to flourish in eminently artificial stations.

Conspicuous floral effects are only noticed in the familiar flowers of garden-cultivation, collected from milder climes. In favourable seasons the last weeks of February afford the first crop of yellow Crocus, followed about a week later by the blue Crocus (*Crocus vernus*), together with early bulbous forms as *Scilla bifolia*, *S. sibirica*, *Chionodoxa* (Feb. 13), *Leucojum vernum* (Feb. 14), *Muscari comosum*. *Helleborus foetidus* and *H. orientale* succeed *H. niger* of the autumn: similarly to the autumnal forms *Viburnum Tinus* and *Daphne Mezereum* is added the spring-flowering *Daphne Laureola* (Jan. 1). But such data for gardens and planted specimens in sheltered situations are still largely deceptive, and serve to mask the much slower advance of the season in open country; as again they express the attempts of human activity in anticipating the season.¹

In an average year the first week of March may be taken as decisive. There is no mistaking the meaning of the flowering of the indigenous Hazels and Alders, conspicuously festooned with masses of drooping catkins. The Elms (*Ulmus campestris* and *U. vegeta*) stand out dull-red against the sky with clustered inflorescences; and the Poplars, if not fully

¹ Cut blooms of Scilly Narcissi (vars. of *N. Tazetta*, *N. papyraceus*, *N. maximus*) abundant in the florists' shops, emphasize the difference in the climate of the extreme SW. sea-board, more than a month in advance, at a distance of some 150 miles farther South. Flowers in shops include *Mimosa dealbata* (from early January), Narcissus 'Soleil d'or', and Trumpet Daffodils: Scilly Daffodils from the first week of February: Feb. 20, 1924, in consequence of a Dock strike fresh Narcissus came from Jersey by aeroplane.

catkined (*P. canescens* ♂, ♀, *P. candicans* ♀) show the inflorescence-buds rapidly breaking out (*P. pyramidalis* ♂); though there is no change so far in the larger woodland trees (Oak, Ash, Beech, Birch, Sycamore), and the flowers of any herbaceous plants are but the barest advance guard of the season (Primrose, Violets, Anemone) mingled with a few alien weeds. Yet the Elder is definitely breaking out into green foliage in sheltered situations; the buds of the hedgerow Hawthorn show green at the tips, planted Siberian Larches are covered with the green tufts of young needles, and the garden evergreens *Euonymus japonicus* and *Ligustrum japonicum* (Privet) are putting out their new shoots among the foliage damaged by winter frosts. *Aucuba japonica* shows large breaking buds, and green leaves break out on Gooseberry bushes and the garden *Ribes sanguineum* (Feb. 26). The staminate catkins of the Sallow (*Salix caprea* ♂) come on in the early weeks of March, in sheltered situations, being normally at their best on Palm Sunday, when Easter falls at the end of the month.¹ In early seasons, with Easter late, no trace of them may be left, but the demand may be supplied by later coppice growths of *S. cinerea*. The early weeks of March are also remarkable for the flowering simultaneously of many planted Cupressineae (*Cupressus Goveniana*, *Chamaecyparis Lawsoniana*, *C. Nutkatensis*, *Thuja gigantea*, *Biota orientalis*, *Juniperus sinensis*, *Sequoia sempervirens*, *Libocedrus*, and late individuals of *Taxus*). The pastures begin to show a new growth of grass, though aquatics are still liable to be wholly submerged by flood-water. *Caltha* in flood-meadows is retarded by the low temperature of the river.

On the other hand, garden-plants come on rapidly; the swelling and breaking of the foliage-buds being as remarkable as the blossoming *en masse* of early-flowering introduced trees and shrubs. Roses break out into leaf, and are soon wholly green. The terminal buds of Lilacs enlarge and break out very conspicuously, and on Laburnums, *Ribes*, and Clematis, buds are moving actively. Flowers break out in full floral display on *Forsythia* (yellow), *Prunus pissardii* (white), *Cydonia japonica* (scarlet), Pink Almond, *Viburnum Tinus*, and early Rhododendrons. Pear-buds swell and break out, and early Plums begin to bloom freely in gardens and orchards.

Eranthis has flowered out, though Snowdrops and Crocuses are still at an optimum; but mingling with them come more definitely Spring flowers—as *Arabis albida*, *Lathyrus vernus*, *Iris reticulata*, *Viola odorata*, Primulas (Polyanthus), *Corydalis bulbosa*, *Lamium maculatum*, *Vinca major* (March 1), and the first planted Daffodils, Rosemary, and *Doronicum* (March 5).

Either in early March or later in the month, a mild spell, as an incipient 'heat-wave',² will bring out associated animal life: hibernating bats (March 6), Ring Snake (March 26), frogs and toads (March 7) begin to appear in open mild weather: together with hibernated insects, Cockchafer (March 6) and hibernated butterflies (*Vanessa Io*, Peacock, March 3; the Brimstone, *Gonopteryx Rhamni*; small Tortoiseshell, *Vanessa Urticae*, March 18; Small Cabbage White, *Pieris Brassicae*, March 27). Early Hive-bees may be observed gathering pollen from Snowdrops, *Leucojum*, and early Crocus on sunny days from mid-February on; though other familiar insect-forms are not usually out before the end of the month (*Eristalis tenax*, *Anthophora pilipes*, March 16; *Bombylius*, and *Bombus terrestris*, March 25). At the first drying days, with sun and wind let into the woodland, mosses begin to shrivel up, and become once more

¹ The utilization of the flowering shoots of *Salix caprea* ♂ as 'Palm' on Palm Sunday, followed the rule of the Holly at Christmas. Beyond the white, spinous, and irregular Blackthorn, there is no other decorative plant in the indigenous vegetation at this time.

² The first half of March 1893 was so warm and fine that every one came out in straw hats in the last week of the Hilary Term.

inconspicuous; lichens shrink in volume, and residual Fungi are concealed in new growths.

Though the advance of the season as first traced in the appearance of introduced garden-plants is largely fallacious, the time from the first definite signs of new growth (Feb. 15) to March 15, may be said to represent the real beginning of spring, as the winter resting-buds begin to stir, though some move faster than others. The period of full production of the new foliage may be delayed, and may take another two months to complete; but it is this development of the new crop of photosynthetic leaves, rather than the early flowering of blossoms mainly laid down in a previous summer, that constitutes the essential feature of spring, as expressing the renewed capacity of the plant-machinery for utilizing solar energy, and so continue its autotrophic activities.

III. HALTING SPRINGTIME.

To the distinctly wakening period of the first weeks of March succeeds a long period of the slow dragging recovery of the woodland flora, characterized by extremely variable weather, predominantly cold and bleak, though subject to spells of summer warmth and brightness which are remembered as typical of April. Yet the mean temperature is slowly rising, the hours of sunlight gain rapidly in duration and intensity, and vegetative growth slowly makes good in spite of constant setbacks. This period normally includes the whole of the month of April, and may be regarded as extending, in extreme cases, from mid-March to mid-May; or more especially as just covering the six weeks of the *Easter Vacation*,¹ usually one of the most uncomfortable periods of the year, in which full spring appears to be always coming, but not yet arrived, and the weather is likely to be bad (e.g. with snow on the ground) at the end as at the beginning.

The most striking physical factor is the rapid gain of daylight, at the rate of nearly two hours a month. The hours of possible sunshine extend from $11\frac{1}{2}$ in mid-March to $13\frac{3}{4}$ in mid-April, and $15\frac{1}{2}$ by mid-May. Yet throughout April the average (40 years) is but $151\cdot4$ total hours of bright sunshine (i.e. $5\cdot05$ per day).² Such mean records, however, afford little guide to the possibilities of the month; the range being from $84\cdot2$ to $252\cdot8$, and fine bright days may give over 12 hours sun (max. recorded, $13\cdot8$).³ The cloud-period is 75.5%, thus working out as about one fine day to three dull or wet. The increasing intensity of the light of the sun, now climbing the sky at greatest rate, is seen in the fact that, while at the Equinox the altitude at noon is $38^{\circ} 14'$, it is $42^{\circ} 24'$ on April 1, and $53^{\circ} 0'$ by May 1; though the effect is less dazzling as the sun gets above the ordinary angle of vision.

To the added intensity and duration of possible sunshine is added the effect of a steady correlated rise of temperature; a mean maximum around 55° F., and a mean minimum about 40° , indicates mild and temperate conditions; but fine days will give a temperature of over 120° in the sun (max. recorded, $131\cdot4^{\circ}$, Apr. 27, 1916), and cold nights may drop to frosts with minimum at $16\cdot1^{\circ}$ (Apr. 12, 1912).⁴

¹ The duration of the Easter vacation has been established to admit of the observance of Easter as a movable feast (from March 25 to April 25), allowing the range of a full moon; and the ancient festival of spring renewal may be said to fall equally happily at any time during this period.

² Radcliffe Observatory Records, LII, p. 103.

³ loc. cit., LI, p. 213.

⁴ loc. cit., LII, p. 105.

Rainfall is again equally variable: the tradition of April showers is not always maintained; the average (of 70 years) gives 1·720 in. for the month.¹ It is interesting to note that the only two months in the year popularly associated with abundant rainfall, February and April, have the lowest record of the year in inches. This again suggests the inadequacy of meteorological records giving net fall; the biological effect is a relative one, largely dependent on the amount of evaporation, and a small supply in frequent showers or drizzle may be far more effective than a few heavy falls. On the other hand, the range is so wide that the 'average' becomes meaningless,—from a minimum total of 0·02 in. (Apr. 1912), to a maximum of 4·309 in. (Apr. 1908).²

In all these respects the climate of the month is one of extremes. Dry cold winds from the N. and E.,—the more penetrating as the land is denuded of trees, and what trees there are have no leaves,—continue for periods of 2–3 weeks, and may be associated with brilliant and continuous sunshine. But clear nights bring frosts and chilly mornings. Wet spells of SW. wind, equally prevalent, imply mild conditions of temperature, open to chills after evaporation of the rain, but the nights free from frost and the days cloudy with greatly reduced insolation. Of the two extremes, the former is the more injurious to plant-progress, as it is also equally unpleasant to human beings. Such spells, early in the period, have been traditionally indicated as 'Blackthorn winter'; and they are even more generally associated with the blossoming of the garden *Forsythia*, as a 'Forsythia winter'. The traditional blend of 'March winds and April showers which bring forth May flowers' well summarizes the situation, in which the alternating periods are by no means so regularly established to time; although the general result is the same, and severe frosts and bitterly cold winds may occur as the last kick of winter in late April and even in early May.

On April 25, 1908, a heavy fall of snow (16 inches) flattened out the new growths after the Daffodils were all out. April 15, 1921, a sudden snow-squall gave the curious effect of the Horsechestnuts and other early trees in full canopy of new foliage, as also Crab Apple and Cherry blossom, weighed down with a snow mantle. Bleak weather is commonly continued into the first weeks of May, giving late seasons, as indicated by the hedgerow Hawthorn not flowering till well after May 1. Yet in 1893 the Hawthorn was practically over before the first of May, and typical mid-April flowers of garden-cultivation (as *Fritillaria imperialis*) blossomed at the end of Hilary Term (March, 2nd week).

In such cases biological data (as in the case of meteorological) require to be averaged up for ordinary years, which occur possibly two out of three.

Thus, early seasons, as indicated in the preceding sections, are one side of the story, the effect of which is commonly marred by a halting period with recurrent lapses of cold wind, the chilling effects of heavy rain, night frosts, or a cold wet soil, which express the more usual delayed spring of the Oxford Clay area, as one of the most backward of the country; in which the effects previously recorded may not be visible for 4–6 weeks, and there is often little real advance until May, whatever may have been the initial favourable conditions of the earlier months of the year.³

¹ Radcliffe Observatory Records, LII, p. 102.

² The record April of recent years was 1893: rainfall for April and March together being less than $\frac{1}{2}$ inch; in each month 20 days recorded as fine. April gave May weather, as April weather had characterized the previous March, with corresponding advance in the flora.

³ The very fact of the long dragging period of spring recovery prompts the outdoor naturalist to look for each new flower that opens and record the date, as affording some indication of the

March 21 has been established as the empirical date for the official commencement of the astronomical year, from the relation of the earth to the sun at the Vernal Equinox, and it is hence equally interesting as a fixed point in the floral year. In many years at this time there may be mild weather, and a temperature of over 60° F.; but more frequently it is characterized by bleakest dry East winds, intense sunshine and a temperature averaging 40°. Plant-life of woodland, pasture, and water, is still predominantly perennating. The larger trees are wholly leafless: Conifers stand out green, and dead Bracken covers the ground as a brown mantle: but the buds of most trees have begun to swell, if not definitely to break out. Hazels and Alders have practically flowered out. Early Willows (*Salix caprea*, *S. purpurea*), Poplars (*Populus canescens* ♀, *P. tremula*, *P. pyramidalis* ♂), and Elms (*Ulmus campestris*, *U. vegeta*, *U. montana*), are in full bloom on the leafless branches, and herbaceous plants (*Arctium*, *Ajuga*, *Sanicula*, *Scilla*, *Euphorbia amygdaloides*, *Mercurialis*) are pushing new foliage-shoots in the undergrowth; while the first new fern-fronds may be seen emerging (Bracken and *Lastraea*) in sheltered glades. Early spring flowers begin to come on normally. What were rarities or feeble specimens a month previously, now become general and well developed: each station adds its new forms.

By the last week of the month Primroses, Wood Anemones, Violets (*Viola hirta*, *V. Riviniana*, *V. sylvestris*) and Celandines (*Ranunculus Ficaria*), show in profusion in woodland clearings, with the addition of underwood forms as:—*Glechoma hederacea*, *Potentilla Fragariastrum*, *Luzula pilosa*. Hedgerows add *Lamium album*, *Geranium Robertianum*, *Viola odorata*. To the increasing production of Daisies and large Dandelion capitula, the pastures add *Luzula campestris*. Woodland, waste, and hedges show Blackthorn (*Prunus spinosa*) whitening with blossom, and sandy soils give Broom (*Cytisus Scoparius*). Swamp-woodland affords *Caltha* in full growth, though it may be delayed in cold flood-water of the alluvial flats, and the first fertile shoots of *Equisetum Telmateia* begin to shed spores at the ground-level. To the weeds of cultivated ground are added:—

<i>Cardamine hirsuta</i> ,	<i>Lamium amplexicaule</i> ,	<i>Veronica hederæfolia</i> ,
<i>Viola arvensis</i> ,	<i>Erodium cicutarium</i> ,	<i>Arenaria serpyllifolia</i> .

The first more definitely aquatic forms appear, as *Ranunculus Drouetii* in shallow ditches, and *Petasites officinalis* beginning to push conspicuous flower-spikes on stream banks.

Plants in garden-cultivation present greatly increased rejuvenescence. Leafy buds are breaking out green on Lilacs, Roses, and flowering shrubs as *Kerria*, *Buddleia*, *Weigelia*, and *Cydonia japonica*. The flowers of decorative forms as *Forsythia*, Pink Almond, *Prunus Pissardii*, make a bold show against the strong winds; the chance of a few mild damp days making it worth while to cultivate them. Crocuses are past their optimum, and Narcissi beginning to come on. In allotments where the soil is sufficiently dry, Broad Beans, Peas, and early Potatoes are put in.

advance of the season. Hence the prevalence of phaenological records, often industriously pursued into May, but really of little value. The range of error is wide, even in the same district; difference of soil and situation may give more than a fortnight range (cf. Shotover slopes on dry sand and the cold clay of Bagley Wood). Such records are interesting as the expression of the slow long-drawn out change, and the eagerness with which the warm weather is awaited. It is obvious that spells of mild weather might fall at any date, or be spaced nearer or farther apart in successive years, and the same effect may be noted over the range of a month. The wandering of the movable feast of Easter itself, from March 25 to April 25, over a moon-period, is the expression of the same vagueness in spring recovery, and the effect is the more obvious when an early Easter is associated with an early spring, or *vice versa* (1924). This, in fact, supplies a reason why Easter has not been given in the past the fixity of Christmas so clearly defined by the winter solstice.

With recurrent spells of E. wind, liable to last for a fortnight or so, it seems remarkable that plant-life should so wake up ; but the machinery has been started and cannot again be stopped, though it may slow down. The first foliage-leaves of the new shoots may be blighted (Siberian Larch, Weeping Willow), and the early crops of flowers wholly wasted.¹ Such spells may readily convert what has been so far a forward season into a backward one. In such a time all breaking leaf-buds are at a standstill : flowering stages mark time : Pink Almond, *Cydonia japonica*, *Forsythia*, and *Prunus Pissardii*, show flowers half-expanded, but never functional ; the Crocus blooms die off after a week without opening. Thus while in most favourable seasons the flowering time of early spring flowers may be well advanced by April 1, in other years there may be little trace of flowers of any kind at April 15, and even Primroses be scanty on 'Primrose Day' (April 19).² Such seasons of cold winds and keen light affect both plant and animal life as the most fatal and depressing time of the year. In woodland and hedges, ditches and pastures, the debris of the vegetation of the past season is still the most conspicuous feature. New growth, though beginning, still shows but little progress above the wreckage of dead stems and leaves of the previous year, and this is the more emphasized in allotment areas and the squalid back-premises of village districts, revealing everywhere the dirt and the rejectamenta of the urban fringe accumulated over the dark winter months. On the other hand the economical value of such keen winds is seen in the solution of the problem of rapidly drying the soil for agricultural and horticultural operations, the more apparent in clay areas where cattle trample foot-paths into mires a foot deep. The traditional value ascribed to a peck of March dust does not refer to the familiar and abounding dust of the roads of the 18th and 19th centuries, now much reduced by the use of tarmacadam, as to the dust blowing off the surface of arable land in days when roads were only grassy rides.³

With a prevailing warm wind and bright sunshine the budding of the trees and general growth of vegetation makes as much progress in a few days, as in as many preceding weeks, and a week will do much to transform the general appearance of the countryside. In an average season April 1 and the first week should mark the beginning of such changed conditions,—in exceptional years a week or fortnight previously, in delayed seasons, a fortnight or more later,—and new features are presented in all departments of the flora. Foliage-shoots push rapidly, flowers enlarge and multiply, leafy buds begin to break out on the majority of trees, and give a new and welcome effect as seen against the sun.

The woodland high-forest is still bare, though Sycamore and Horsechestnut (planted) may be half broken into leaf. Birch and Hornbeam bud and produce young leaves and staminate catkins at the same time. Several Poplars and Willows are at their optimum (*Salix caprea*, *S. triandra*, *S. purpurea*, *Populus nigra* ♂, *P. serotina* ♂, *P. candicans* ♀). In the shelter of the underwood Blackthorn is at its best, with *Prunus Avium* ; Plum trees are whitening in orchards and gardens, and early Pears break into flower and leaf, as also the first blossoms of the Cherry Laurel. Gorse and Broom come on freely in gardens and open waste.

¹ *Jasminum nudiflorum*, *Forsythia*, *Prunus Pissardii*, do not fruit at all ; Pink Almond only produces a crop of fruit in exceptional seasons. Yellow Crocuses are wholly sterile. Insects are still scarce, and insect-pollination, except by a few hive-bees, wholly negligible.

² 'Primrose Day' is interesting to the botanist as commemorating the death of Charles Darwin (1882) whose connexion with the Primrose was at least as significant as that of rival contestants.

³ In the mild wet spring of 1923, no dust was blowing even on dry roads before April 20 : in the late dry spring of 1924, even the woodland was dry and dusty with debris of dead leaves.

Mercurialis is dominant in damp woodland, and the undergrowth is sprinkled with Wood Anemones, Primroses, Celandines, and Violets. Cleaned forest plots of the 2nd and 3rd year's planting, and open clearings, may be spectacular with carpets of these flowers; the floral display being more attractive than at any other time of the year:—stretches of white Anemone, yellow Celandine, and blue *Viola hirta* with mingled clumps of Primroses, *V. Riviniana*, *Luzula pilosa*, &c.

In hedgerows Hawthorn and Elder are filled out with green leaves, sufficiently to colour them a fresh green, and change the aspect of the countryside, as the hedges now begin to obscure the view. Blackthorn bushes mingle white conspicuously among the green Hawthorns, and the Elms break out into small leaves from below upward. The hedge bottoms fill up with rank foliage of *Alliaria*, *Arum*, *Anthriscus sylvestris*, *Galium Aparine* and *Lamium album*; to the new flowering shoots of the last are added the first flowers of *Alliaria* and *Lychnis dioica*, and in exceptional seasons the first *Arum* spathe. On stone walls *Draba* is already shedding seeds, and new flowers appear, as *Arenaria serpyllifolia* and *Saxifraga tridactylites*. *Poa annua* is still the only grass in flower, though Foxtail spikes are pushing, and the black spikelets of *Carex riparia* are conspicuous in water meadows and ditches. Pastures begin to show the first Cowslips and *Cardamine pratensis*. In drier levels, with the increasing supply of Daisies and Dandelions,¹ appear the first new Buttercups (*Ranunculus acris*), and the spikes of *Plantago lanceolata* (♀). Alluvial meadows are hunted over by children for the first Snakes-heads (*Fritillaria Meleagris*) in the bud stage, and the first Fritillaries and Cowslips are offered for sale in the streets. Of the sub-aquatics, *Caltha* begins to colour tracts of water meadows, *Pelasites* is at its optimum, with flower-spikes over a foot in height, *Ranunculus Drouetii* stars the ditches of Port Meadow, and *Equisetum Telmateia* in hill-swamps shows abundant fertile spikes now a foot high.

Weeds of cultivated ground increase,—*Medicago lupulina*, *Lamium amplexicaule*, *Urtica urens*;² the common Groundsel is already shedding seed.

Cottage gardens begin to afford their full display of Spring flowers, and are gay with colour-forms and varieties of Narcissus, Tulip, Hyacinth, Wallflower, Pansies, Daisies, Polyanthus, *Aubrietia*, *Arabis*, *Fritillaria imperialis*, with *Kerria japonica*, *Cydonia japonica* and *Buxus*.³

The same mild break which brings out the familiar flowers of Spring also bring out all residual hibernated animal life, as well as the first of the new broods (cf. *Andrena fulva*, of gravel paths, Apr. 7); Comma Butterfly (Apr. 1) and Brimstone (Apr. 2).

Although the stage of the initial swelling of the buds of some of the trees heralds the approach of renewed photosynthetic activity in the plants of woodland, garden, and hedgerow, the complete recovery of the plant-mechanism is still a matter of considerable time, and subject to frequent delays. The problem of restoring the foliage of deciduous trees is by no means so simple as that of putting new leaves back on the old branches; but it involves the production of new shoots to display the new foliage.

¹ Dandelion capitula, to 55–60 mm. diam., and 10–12 per sq. yard, are functional for a week, Daisy capitula are functional for 3 weeks.

² In sheltered spots many strays of the preceding autumn may recover and continue flowering:—*Urtica urens*, *Linaria Cymbalaria*, *Scandix*, *Heracleum Sphondylium*, *Matricaria Chamomilla*, as also cultivated Cabbage, Turnip, and Radish.

³ *Magnolia acuminata*, *Pyrus spectabilis*, and the first blue *Iris germanica* (April 7). *Ribes sanguineum*, *Berberis Aquifolium*, *B. Darwinii*, Rosemary, *Doronicum*, *Myosotis*, the early Rhododendrons, and fruit trees as Pear, Plum, and Cherry.

The primordia of the young leaves may be all inside the buds, but the growth and elongation of the new 'shoots of the current year', which space the growing leaves to their working positions in the sunlight, is a work of time and careful adjustment. Hence in the case of deciduous trees the new spring-time is not only a period of the growth of new foliage-leaves from the minute size in which they perennated in the winter-buds, but also of the active formation of an entirely new set of shoots, to the limit of the demand and available light-supply. Trees grow a size larger in the process; herbaceous plants with continuous output of leaves similarly require to develop their main axes and acquire mechanical stability. As in the case of the destruction of the foliage in the autumn, this work is spaced out over a period of 1-2 months; and it is not until mid-May that woodland trees begin to attain anything like their summer density of foliage. The time required by each species is open to a considerable range of variation, dependent on chances of weather, the amount of shelter, or exposure to wind; while even with equal conditions, in the case of trees growing side by side, there is often an individual factor (of 1-2 weeks) which may largely counterbalance the effect of more obvious external conditions.

Even in the most favourable seasons the breaking out of the foliage-leaves of the great majority of indigenous trees is long delayed. Though garden-forms may be well advanced, mid-April finds the larger trees of woodland and hedges predominantly bare, though budding is general. The new foliage comes on rapidly towards the end of the month, to be fully developed in the early weeks of May. Of the particularly early forms, the Elder is conspicuously the first, with the lianoid *Lonicera* and *Clematis* of sheltered woodland. Hedge-row Hawthorn should be breaking into green leaf by April 1, enough to tint the landscape, and be fully clothed by April 15.¹ The Weeping Willow, though the first of all to begin, is readily delayed, and may be no further on in mid-April or even mid-May than on March 1. Commonly it is overtaken by *Salix alba* and *S. fragilis* by April 15. *Aesculus*, Sycamore, and Mountain Ash, as planted trees, may have their foliage half-grown before mid-April. The main series of other trees begin to come on at this time; the leaves breaking out freely on coppiced Hazel and Elm suckers. The time required, from the first breaking green of the buds, to full extension of the first leaves of the new shoots, averages 4 weeks; though the new shoots may continue to grow into May and June.

A few trees are conspicuously late, as Oak and *Juglans* (with the flowers), Ash and Black Italian Poplar (after flowering), and the Lime, *Robinia Pseudacacia*, as also Plane, Fig, and Vine, as planted forms (before flowering). In this case the buds only begin to break out after mid-April, and the new foliage is scarcely attained by mid-May.² Evergreen Conifers are backward, and appear dingy against the fresh green foliage of the deciduous trees. Deodar is the first to break out new foliage, followed by green tips to Common and Sitka Spruce and the breaking of the buds of early Pines (*P. Banksiana*, *P. montana*, and *P. Laricio (austriaca)*).

Beyond the production of the new crop of photosynthetic shoots, one of the most striking features of the Spring rejuvenescence is the early flowering of many trees and shrubs from mid-winter on, apparently wholly independently of the vegetative leaves in Jan., Feb., March, with the young leaves in April, or still more abundantly with the full growth of the new foliage in May,—as indicating that the living activities of the plant are not to be measured by the functional value of the foliage. Thus, in woodland the Hazels and Alders of Jan., Feb. are followed by the early Willows (*Salix caprea*, *S. purpurea*), Elms (*Ulmus campestris*, *U. vegeta*, *U. montana*)

¹ April 28, 1924.

² In late springs not by mid-June (1923).

of early March, and Poplars (*Populus nigra*, *P. tremula*, *P. canescens*) with Blackthorn at the end of the month, all flowering out before any effective breaking of the leaves. Cultivated forest-trees as *Juglans*, with smaller decorative trees and shrubs (*Fasminum nudiflorum*, *Daphne Mezereum*, *Chimonanthus*, *Forsythia*, Pink Almond) show similar phenomena; as also do evergreens (*Taxus*, *Cupressus*, *Thuja*, *Juniperus*, *Viscum*) flowering on shoots bearing the leaves of the previous season, and thus occasioning less remark. Many of these forms are the imported aliens of mild climates; but there is no doubt about the hardy indigenous trees as Ash, Wych Elm, Hazel, Alder, and Blackthorn, even if some Poplars and Willows are open to the suspicion of having been introduced and maintained by human agency.

The consideration of such phenomena opens up wider aspects of the general relation of the inflorescence region of a plant to its photosynthetic shoot-system: the former, in its subsequent production of seeds, being fed entirely by food produced by the latter,—and these interrelationships are subject to modification by the effect of time-factors, as rendered insistent more particularly by seasonal change. Thus the photosynthetic shoot-system can only do its work under favourable conditions of water-supply, temperature, and sunshine; the essential reproductive mechanism, enclosed within the tissues of the plant, and nourished independently of light, varies mainly in rate of development according to the temperature. That is to say, during the early months of the year, while the leafy shoots are renewing full canopy and functional activity, there are possibly 2–3 months of warm weather which may be still usefully employed by the non-photosynthetic regions of the plant; and, in the case of forms restricted to a short favourable season in the year, and requiring time to carry out the reproductive processes of the seed-stage, these months may prove an important asset, when temperature is the critical factor.

Various expedients and compromises are shown in effecting these relations, as time-factors are associated with new morphological features in shoot-construction. These may be briefly indicated, so long as it is understood that no hard and fast rule can be drawn, and the different stages grade into one another; but some of the more familiar examples may be considered on their merits.

Resting buds should be examined in longitudinal section at Aug. 15 (hot season), Oct. 15 (leaf-fall), Dec. 15 (winter-perennation), Feb. 15 (beginning of Spring), March 15 (buds swelling), to note when the flowers are really laid down, and their progress.

I. In the more general and presumably more primitive case, an inflorescence-region, terminating the 'annual shoot', may be taken as epitomizing the life-story of the plant as a whole (e.g. a single stemmed annual plant may be regarded as a tree-form *reduced* to the expression of one annual shoot), and the general relation of the inflorescence-region to the vegetative system may be visualized by considering the case of a herbaceous annual as a Sunflower (*Helianthus annuus*) or a Bean (*Vicia Faba*), which is sown, attains full vegetative habit, and then flowers out and fruits to perennate in the seed-stage. Much the same thing on a large scale is seen in the working of the tree with its multiplicity of annual shoots, each producing its own leaves and actively photosynthetic, to attain finally a reproductive stage, in which the food elaborated by the foliage is utilized in the seed output of the same shoot. In the special case of a large tree each annual shoot thus attends to its own affairs, and there is no marked diversion of food-supply from one shoot to another. This condition of things may be all quite satisfactory in a climate with long vegetative period,

or where active growth and metabolism may result in the production of the entire shoot and its fruit in one season. But shortened seasons and reduced metabolic efficiency lead to variations and modifications of the theme.

In this country few woody plants present such an elementary state of affairs. Perhaps the most interesting example is *Clematis Vitalba*, just reaching the centre of England, more or less as a human associate. The long trailing summer shoots, to 6 ft., terminate in panicked systems flowering in July, and fruits are matured in the autumn; the leaves being drifted away by December and the fruits by next April. Again, the common Ivy, evergreen, with a slower rate of growth, produces annual shoots terminating in a panicked system of flowers not functional until the autumn (Oct., Nov.), and visited by the last insects of the season. Similarly, the evergreen Cedar produces flowers terminating leafy spurs in Oct. and Nov., to be wind-pollinated. Both these plants belong to the mountain ranges of Central Asia and the Mediterranean region, and in both the flowers come on too late to mature fruit in the same year; the Ivy ripening its berries in spring (March, April), and the Cedar taking the whole of the succeeding summer to mature its cones (Nov., Dec.). As an example of more active metabolism may be compared forms of *Buddleia variabilis* (esp. *var. magnifica*), a garden-introduction from S. America, of which the 6-8 ft. leafy shoots, functional from March, will flower 1-2 ft. panicles (August), and fruit the same season, as well as continuing to lateral panicles of the second degree.

With an unfavourable northern climate and reduced vegetative growth, it will thus prove an obvious advantage to have the flowers out when conditions (including insect-life) are at their optimum; and also, if possible, to get fruits ripened before autumn, in order that the seeds may perennate when the rest of plant-life is also closed down; and where the flowering period cannot be hastened to earlier in the year, it may be delayed until the next season,—the latter being the obvious line of least resistance.

In the simplest case, the terminal panicle (inflorescence-system) elaborated by the shoot at the expense of food-material gained during the summer months, from leaves that were only formed in May, is likely to lag behind; and if only in the bud-stage in late autumn, it tends to perennate over the winter, and so flower as soon as conditions become favourable at any time in the early spring months.

A good example is afforded by the Laurustinus (*Viburnum Tinus*) of the Mediterranean region; the evergreen shoots developing terminal flower-systems in July, and the panicle ready to flower in October in sheltered situations, or during any of the winter months, but only reaching its optimum in April; both flowers and fruit-formation being delayed to a second season. The same effects are exaggerated in the indigenous deciduous forms *V. Lantana*, *V. Opulus*; the terminal panicle of the former perennating very conspicuously in a rudimentary stage with little bud-protection (March), to enlarge in early spring, and flower with the new leaves in early May, and thus not ripening the berries until the second summer (Sept.).

Early spring flowers are thus to be regarded as delayed from a previous autumn, and present the reproductive mechanism extended more or less into a second season; while the foliage-leaves of deciduous forms last but one, and the two sets of phenomena are not accurately adjusted. Interesting examples of delayed and reduced terminal inflorescences perennating 'naked' over the winter are to be observed in *Alnus* catkins, *Betula* (♂), and further limited to a triad cluster in *Viscum*.¹

¹ The subject is admittedly complicated as it includes other associated factors, as the restriction of the output of the inflorescence-system to fewer flowers, reduced size, or their presentation in special types of ramification-system or secondary aggregation. Case II includes a miscellaneous intermediate collection, and variations may occur in the same tree when monoecious: cf. *Betula* ♂ I, ♀ II; *Ficus* ♂ II, ♀ III; *Juglans* ♂ II, ♀ III.

II. Primary relations may be obscured by the general formation of lateral inflorescence-systems with reduced leaf-output, or in the limit with no green leaves at all; as also by the production of special flowering shoots, as opposed to the purely vegetative buds giving leaders of new growth, with or without a terminal system.

An interesting case of such inflorescence shoots, borne in the axils of the leaves of the current year, occurs in *Tilia*, the last representative in N. Europe of a more tropical family. The leaves come out in May, the flowers function at Midsummer, and the fruits may ripen in October of the same year (though commonly failing in this country). In the case of *Clematis Vitalba* previously considered, the greater part of the inflorescence-scheme may be regarded as similar axillary derivatives of the photosynthetic leaves.

But where such inflorescence-buds, formed in late autumn, are delayed to perennate over the winter, they may break out in blossom early in spring before the new leaves (plants with a terminal system may have such laterals on a reduced scale). This arrangement with the extreme case of no green leaves on the flowering axes, is seen in Hazel (σ^7), Blackthorn, *Salix caprea* (σ^7), *Populus* (σ^7), *Ulmus*, *Fraxinus*, *Juglans* (σ^7), *Forsythia*, Pink Almond, Peach, &c.; and *Larix* (σ^7) is clearly the delayed homologue of the Cedar.

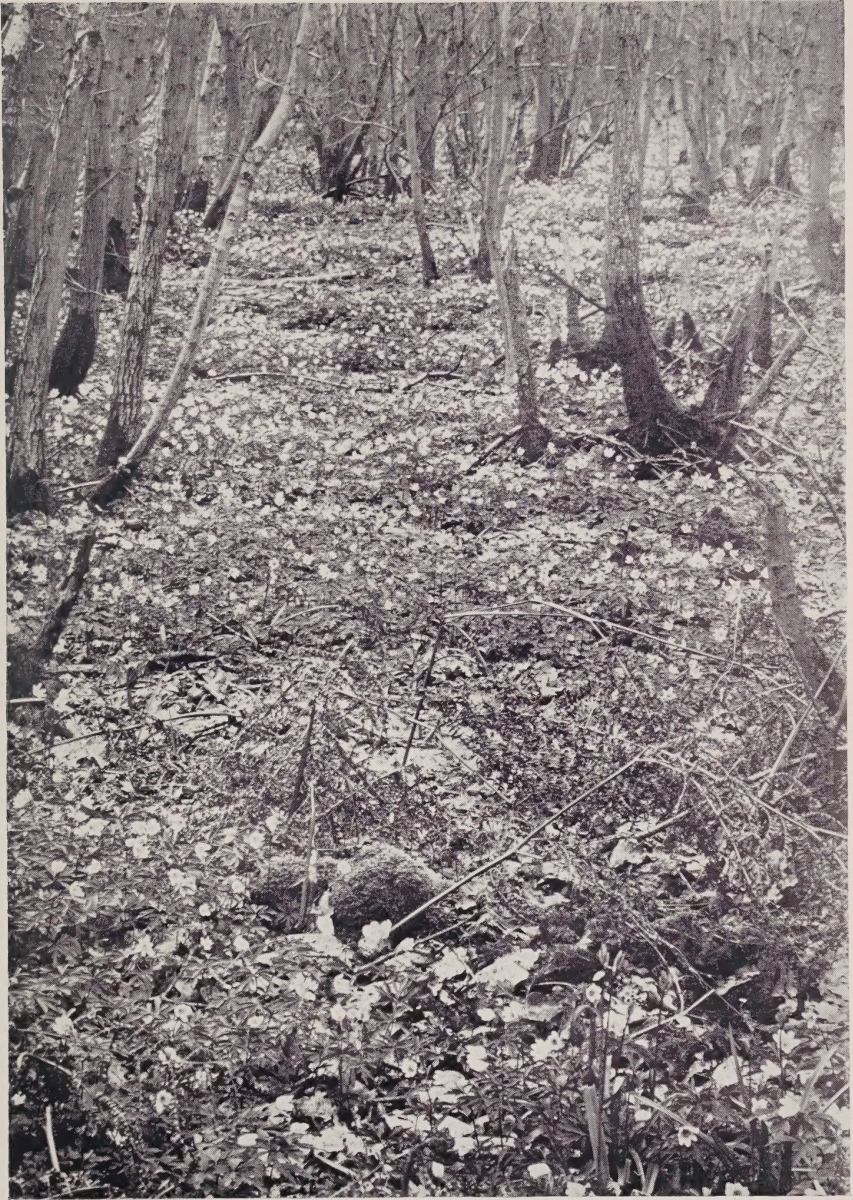
Larix (φ) is borne on a spur-shoot with green needles (April); *Betula* (φ) catkins on lateral shoots with 2 (1-3) green leaves.

III. A more specialized adjustment is commonly found in Northern latitudes, though not necessarily originating there, as a more definite adaptation to a short season, in that the production of both leaves and flowers is *synchronized*. The entire crop of foliage-leaves for the annual shoot, together with the end inflorescence-system, whether in terminal or lateral buds, is prepared in the summer and autumn of the previous season, to break out into flower and leaf simultaneously,—the annual shoot thus working as a whole, and the flowers functioning as the foliage-leaves attain their optimum activity. In this way, again, an appearance of floral precocity has been attained by a mechanism of delay; though the fruits and seeds are still supplied by the photosynthetic output of the leaves of the same flowering shoot. Such co-ordination of vegetative leaves and flowers is to be regarded as a phenomenon of retardation, since both terminal and lateral buds might have come on in the same season as that in which they were initiated, if growth had been sufficiently active; just as vegetative shoots of Willows and Poplars in active growth will branch to the second degree in one season, and the garden *Buddleia variabilis* will flower and fruit on branches of the second degree in a hot summer, as also does the Fuchsia (*F. Riccartoni*).¹

The general effect of such an arrangement is to restrict the growth of the plant to one degree of ramification in each season, and so to establish the convention of the 'annual shoot'; while the system further readily lends itself to the production of leafy 'flowering spurs' as opposed to indefinitely extending leafy leaders.

This case includes the maincrop of spring-flowering trees of April and May; the finest example being the Horse-chestnut (*Aesculus*) of the Caucasian mountains, with its few (4-6) large compound leaves, great panicle of bloom, and few fine seeds ripened in October; also the typical May blossoms of Lilac, Laburnum, and Hawthorn, fruit-trees as Apple,

¹ The yellow-flowered *Buddleia globosa* corresponds in these respects with the type of *Viburnum Lantana*, and flowers in June (setting no fruit). *Salix triandra* has been observed flowering its catkins (σ^7) in the same summer, and the 'Lammas shoots' of the Oak are branches of the second degree conspicuous in late July.



5. *Anemone nemorosa* in Oak-coppice ; Bagley, April 16, 1923.



6. Primroses and Wood Anemones in planted Forest plot (Ash); Bagley, April 5, 1923.

Pear, and Cherry, with Willows as *Salix alba*, Oak (♀), *Castanea*, Beech, *Larix* (♀), *Pyrus Aucuparia*, *Mespilus*, Sycamore, Maples, Plane, Elder, Dogwood, Weigelia, *Ribes sanguineum*, &c.—all flowering in May with the new foliage, and ripening fruit in the same season, to pass as the commonplace of what a deciduous tree in this part of the world is expected to do. The floral reproductive mechanism is now definitely arranged to extend over two seasons instead of being completed in one; and the same general story of retardation may begin to pass on to another degree. Thus the Larch expands its preformed ovulate flower early in April, to mature seed by the second winter; but *Pinus sylvestris*, similarly flowering late in May, with flowers laid down in the previous autumn, leaves its cone over a second succeeding summer to extend into three seasons, and *Pinus Pinea* of the dry Mediterranean into a fourth; as again English Oaks mature their acorns in the second season from laying down the floral shoots, but some N. American Oaks (*Quercus rubra*) take in all a third.

It may be noted that each type is an interesting study on its own merits. They have not all come the same way; nor have they been necessarily subjected to the same climatic history in the past. The response varies within one and the same family; just as trees and herbaceous perennials may occur in the same alliance, and evergreens and deciduous forms in the same genus.¹ But it is evident that the general results in these respects observed in indigenous trees are quite as diverse in their mixed origin, as are the forms collected from the ends of the earth for garden-cultivation, and indigenous trees thus appear as a miscellaneous set of residual migrants from older floras.

This relation of the spring flora to the production of leaves and flowers by deciduous woodland trees leads to the consideration of the same class of phenomena obtaining in perennial herbaceous forms of the woodland base, open clearings, or pastures. Similar effects of retardation tend to the extension of what was originally one season's work over two; and the fact that the earliest spring flowers are to be regarded as late stragglers of the preceding autumn has already been indicated, although many of them only attain their optimum in April and May (Daisy, Dandelion). Again, where the new leaves come on with the flowers, the plants may be characteristically spring-flowering, though a few may come on in a mild autumn (Primrose, *Viola Riviniana*, and more rarely *Mercurialis* and *Anemone nemorosa*). With more definite delay the flowers are synchronized with the new foliage as more typical spring flowers: cf. perennials as *Tussilago Farfara* (flowering before the leaves), *Petasites officinalis* (with the young leaves), *Scilla nutans*, *Ranunculus Ficaria*, *Caltha palustris*, *Orchis mascula* (with the functional foliage).

The intense insolation of the spring months before the leaves are on the trees, combined with the sheltering effect of the branches from cold winds, leads to the possibility of a special short-season ground-flora in woodland, which (given adequate temperature) may complete its functional work in both foliage and flower before the end of May. This short season flowering of the woodland base is perhaps the most beautiful effect of the North Temperate spring revival; not so much in variety of type, as in aggregate mass of individuals and colour-effects. The most characteristic plants of early months (mid-March to mid-May) are the Wood Anemone, Dog's Mercury, Bluebell, Primrose, Violet, Celandine. These are essentially woodland forms, some of which may extend to pastures, just as Daisies and Dandelions of the latter may be intrusive in woodland clearings.

¹ Cf. sp. of *Euonymus*, *Viburnum*, *Prunus*, *Berberis*.

Their popular names express their familiarity and conspicuousness in the seasonal change. In all such plants the flowers are cheaply made at the expense of the stored reserves of the previous season, to function as early as possible with the first development of the foliage-leaves; the main work of the latter being utilized in the production of seeds and the supply of perennating structures. In this way the herbaceous perennial of the spring months parallels the case of the specialized tree with early-flowering annual shoots. Annuals and ephemerals are still scanty (*Capsella*, *Cardamine hirsuta*, *Draba*, *Veronica hederæfolia*), their vegetative mechanism also dating from the previous autumn. Perhaps the most remarkable feature of these early-flowering herbaceous forms is their extremely distant relationship, as the specialized end-terms of widely distinct phyletic series, now convergent in their ecological relations.

The most characteristic feature of the spring outburst of flowers is the multitude of blossoms produced by quite a small number of specialized forms; these being again enormously increased in individuals by human association in artificial plant-formations:—cf.

Anemone nemorosa,

Primula vulgaris,

Viola Riviniana (with *V. hirta*),

Scilla nutans,

Mercurialis perennis,

Ranunculus acris (with *R. bulbosus*),

Plantago lanceolata,

Bellis perennis,

Taraxacum officinale,

Trifolium pratense.

the former of woodland clearings, the latter of open pastures; to which may be added *Caltha palustris* of swamp-woodland, intrusive in swampy meadows of the alluvium, and the Fritillary, an undoubted alien, also restricted to these artificial alluvial meadows, the seeds of both these plants being shed at the time the hay is cut. Beyond these dozen forms the output of flowers in other species is comparatively trifling.¹

Primula vulgaris (Primrose) of the gamopetalous family Primulaceae, characteristic of open woodland clearings, forest plots, and coppice undergrowth; shade-enduring and living over periods of rotation in the vegetative condition; at an optimum in the years of clearing and replanting; extending also into artificial hedgerows, and intrusive in mown pastures; comparatively poor and backward on clay-formations, but better on well-drained Corallian, Calcareous Grit, and gravels. Still flowering *en masse* in later April, where not destroyed and uprooted by the public.

At an optimum in open clearings, at the rate of 17 roots to a 4 by 4 ft. quadrate (Bagley Wood); old tufted stocks will give 60–100 blossoms out simultaneously. The pale-yellow corollas, 30–40 mm. diam., and with 25 mm. corolla tube, show mechanism complicated by heterostyly. They are visited by *Anthophora*, *Bombylius*, and *Bombus lapidarius* (♀); the first, on open sands and gravels, is the most effective pollinating agent; in woodland on clay and drift-gravel chiefly *Bombylius*. The plants flower out as May comes on, setting fruit freely in dry sunny situations. The capsules lie out on the soil, and the leaves grow rank. The fruits shed seeds after Midsummer, and the foliage shrivels where exposed to summer drought, but in damp woodland persists until the autumn, when new leaves push up, and a few casual flowers are produced (Oct.–Dec.). These are relatively small and poor; corolla 30 mm., and tube 15 mm., all intercalary growth-zones being feebly developed.

¹ To these are added in May, the Bluebells of woodland, and Hawthorn and Keck of the hedgerows. Wallace (Forests of the Amazon) states that in all his tropical travels he never saw floral output more spectacular, than a field of buttercups, a hill-side with gorse or broom, a mountain with purple heather, or a forest glade with bluebells. Cf. Tropical Nature, 1878, p. 60. 'There is a grandeur and solemnity in the tropical forest, but little of beauty or brilliancy of colour. All is gloomy and solemn, and one feels a relief again on seeing the blue sky.' The spectacular display of flowers is a function of a short intensive vegetative period rather than of continued optimum conditions; hence at a maximum in deciduous tropical woodland and at alpine elevations.

Viola (sp.) Violets, the only genus representing the small family of the Violaceae. Several species are commonly associated in woodland clearings, hedge-banks, &c., and present much the same general organization and floral-mechanism; so much so that many require a second look to make sure of their identity. Insect pollination is obligatory. The plants perennate and endure the woodland rotation, much as *Primula*, and are similarly intrusive in pastures and hedges. *V. odorata* may become a weed in gardens.

The scented form of the full violet-type (*V. odorata*), with rosette-habit and runners, is probably largely alien; local forms (var. *imberbis*, and 'White Violets') are restricted to hedgerows. *V. hirta*, of woodland and banks, is a fine form with similar tufted rosette-habit, but scentless. The flowers may be 24 mm. long, of a bright violet-blue colour; hairs may be conspicuously wanting, but the spur is definitely hooked. On gravel-drift clearings, or drift and clay (Bagley), or on calcareous banks, it gives broad blue expanses of blossom; the flowers often so close together that they show no leaves between; 120 to the sq. foot (Bagley).

Woodland violets of the *V. sylvestris* type range from *V. Riviniana*, with broad blue flowers, 18 mm. over all, characterized by many reticulated veins on the broad anterior petal, and a short spur pale in colour. It is particularly abundant on heathy clearings on plateau gravel, giving blue patches of blossoms. *V. sylvestris* (*Reichenbachiana*), with smaller flowers, has a darker spur, and the front petals are blotched around a paler centre with few veins. These last forms often grow side by side, and may be equally abundant on clay (Bagley); they probably intercross and give intermediates. The foliage-shoots of these forms shrivel in summer drought, but recover in mild autumn, flowering casually from September on. Fruits are shed from Midsummer. *V. palustris* of woodland swamp only occurs on the drainage from the Greensand. *V. canina* does not occur in the local area.

Anemone nemorosa, Wood Anemone, a reduced northern form of its genus, with subterranean rhizome; the flowering shoot sending up a solitary terminal flower on a slender stem bearing three compound leaves only, and attaining a height of 6-10 (15) inches. The flowering plants carpet woodland clearings and cleaned forest-plots, often giving broad white expanses looking like a slight snowfall in the distance (Bagley). They also endure the shade of the woodland canopy, under oak coppice, standard or Sycamore, and culminate in the years of clearance. When associated with Bracken, they flower as the wreckage of the latter decays in spring, and are over before the new fronds push up. They attain an optimum in rides and open clearings where Bracken and Brambles are kept down by woodmen. The white star-like flowers are freely produced in April, increasing considerably in size, and commonly showing a purple tint during the functional period. They expand in full sun, and are markedly heliotropic: they are freely autogamous, and *Bombylius* is one of the few visitors. The crop is usually over by the beginning of May, as the Bluebells begin to come on. In shade under Sycamore, with *Scilla*, 20 to the sq. yd. gives a sparse effect: in open clearings (Ash-plot) 386 to a 4 by 4 ft. quadrate, or 24 to the sq. ft. Dense patches give 60 to the sq. ft., and the maximum noted, 90 to the sq. ft. (Bagley). Fruits are freely formed in mild weather; but in cold spells the entire fruit-head is abstricted; these are conspicuous in late May, and the small achenes are shed in June. The foliage turns yellow, and by the end of the month all overground parts have vanished. The working-period is thus a bare three months.

Mercurialis perennis, Dog's Mercury. A woodland stray of the Euphorbiaceae, and outside the limits of the special genus *Euphorbia* (also with one woodland representative), the last representative farthest north of the older types of this essentially tropical order. In Spring the leafy shoots, a foot or more high, cover damp shaded woodland bottoms with a mantle of vivid green, at best on calcareous tracts, and also intrusive in hedge-banks. In more open situations it may be dominated by *Pteris*. In mixed woodland, leafy shoots grow 30 to the sq. ft., on Calcareous Grit 40, and on Coral Rag as many as 60

(Bagley). The plants are dioecious, and the carpellary individuals are recognized by being less conspicuously 'in flower'. They are essentially fly-pollinated, but may be also assisted by wind. The flowering shoots come on in early March, and are at an optimum in April. Fruits set freely in May, as small two-lobed capsules, more conspicuous in early June, when the seeds are shed explosively. In damp bottoms the green shoots persist until the new ones appear, casually in autumn, or *en masse* in early spring: in summer drought the shoots may be completely shrivelled.

Fritillaria Meleagris (Common Fritillary), a bulbous plant of the Liliaceae, sending up from a small white bulb three inches below the surface, a slender shoot with a few grass-like leaves, to the height of 6-10 (20) inches, and bearing a single terminal, pendulous, purple-chequered blossom, bell-shaped, and 2 inches long.

The plant formerly flowered abundantly in damp alluvial meadows from Ifley to Sandford, in levels preferentially just above the *Caltha* zone, but it is now so far checked as to have practically vanished from the ecological flora in the flowering condition.¹ The flowers are fly-pollinated, but largely auto-gamous; and although comparatively inconspicuous in the grass when seen from above, the effect of the purple chequer-pattern contrasting with the green nectary-stripes, as seen from below against the sun, is very elegant. Individual flowers are readily seen at a distance of 40 yds.: a distribution of 1 to a sq. yd. is sparse, but this may be taken as 5,000 to an acre. When more abundant, 6-10 to a sq. yd., the grass is distinctly speckled purple, and the colour contrasts with the equally abundant yellow *Calthas*. (Christ Church meadow, maximum 20 to the sq. yd., and as many as 6 in a clump within a sq. ft.).

Where let alone, the flowers freely set fruit, as capsules 1 in. long, erecting, and ripening flat discoid seeds in June. These are shed at the time of the early Hay-harvest, and this probably accounts for their very even distribution over the broad alluvial expanses. A white variety is much more conspicuous, and such flowers are often selected for garden-cultivation. Garden-grown specimens alone afford an idea of the full floral effect, and cultivated plants will give two flowers to a stem, and exceptionally 6, in the manner of *Fritillaria imperialis* (B.G.O.). Bulbs can be purchased from Dutch dealers at cheap rates (1s. per dozen).

Normally in mid-April (or about April 1, old style) the change of the season is definitely established; and with a few days of warm wind and a temperature which in the shade may be as much as 70° in the middle of the day, as also brilliant sunshine, especially noteworthy in early morning (as the sun rises at 5 p.m. on Apr. 19), all new developments come on apace. April 15 may be emphasized as 'Budding-time'. All trees are

¹ About the first week of April, the general public, especially school children, are affected with a mania for picking the plant as soon as it appears; the green unopened buds (Snakes-heads) being supposed to expand successfully in water. Once popularized and given a commercial value, these interesting plants are ruthlessly picked and sold by street hawkers (2d. or 3d. for a bunch of a dozen poor blooms), and they are now practically eliminated from all meadows readily accessible to the general public. One now rarely sees a perfect specimen in an open field. The best are seen in the enclosed Christ Church meadow, behind the Barges. Within living memory Ifley Fields were full of blossoms, and nobody thought of picking them; they were also abundant in the meadows at Kennington. A score of small boys taking home large bunches of buds with little colour, at estimate of 500 per child, will thus denude a couple of acres in an afternoon. Nothing short of closing the fields to the public for a few seasons is likely to encourage their growth again. When picked in the bud-stage, the stalks are pulled away from the bulb, after the shoot has had only 2-3 weeks of photosynthetic activity; the bulbs are weakened and take some time to recover. The vegetating shoots may be found on looking among the grass. Supplies sold in the streets come more particularly from meadows above Eynsham and Stanton Harcourt; the plants also grow on the alluvial flats of the Windrush to Witney, and the chief supply is from Ducklington and Hardwick. These alluvial flats being always artificial meadow-land, maintained by mowing (rather than grazing), it is hardly possible to regard the plant as truly indigenous. It is probably a relic of monastic cultivation. In the local river-area it does not occur above the Railway Bridge at Cold Arbour. The optimum crop coincides with the beginning of the Summer Term, but all have gone before Eights Week.



7. *Ranunculus Ficaria* in regenerating clearing; Kennington Underwoods, May 8, 1922.



8. Arum, Bluebell, Primrose, &c., in Underwood ; Spring Copse, Bagley ;
May 17, 1922.

now actively budding (more or less), and the landscape becomes preponderantly green. Hedges block out the distant view, though the high woodland is still delayed. The earliest Oaks show leaf-buds breaking to a yellowing tint, Elms break out in their upper branches. Poplars and Willows (*Salix alba*) are all vested in green: *Populus canescens* is conspicuously grey. Ash, Plane, and Walnut remain late; but stray Beeches and Limes may be leafing, though the majority only show swelling buds.¹ Hawthorns are in dense green leaf, and in sheltered park-grounds the first strays may even show flower.² Plums, Pears, Cherries are in full bloom with the first Apple trees in gardens and orchards. *Prunus Avium* is conspicuous in woodland, and Gorse bushes colour the waste golden yellow. *Salix caprea* has flowered out, *S. cinerea* and *S. triandra* continue, and the Blackthorn is becoming residual.

The woodland base still shows wreckage of Bracken and Brambles, but the new fronds of the former are pushing rapidly, and strong growths may be over a foot high. Woodland clearings, and more particularly forest plots, in which Brambles, Bracken, *Teucrium*, and *Juncus*, are kept down, show as gardens of flowers; the ground being densely carpeted with Primroses, Celandines, Violets (*V. hirta*, *V. Riviniana*), and Wood Anemone, these attaining their maximum floral display in plots of the 2nd to 4th year from planting. As woodland-forms of secondary interest found in smaller quantity may be included:—

<i>Orchis mascula</i> ,	<i>Euphorbia amygdaloides</i> ,	<i>Oxalis Acetosella</i> ,
<i>Adoxa Moschatellina</i> ,	<i>Arum maculatum</i> ,	<i>Lamium Galeobdolon</i> ,
<i>Potentilla Fragariastrum</i> ,	<i>Luzula pilosa</i> ,	<i>Veronica serpyllifolia</i> .

Hedge-bottoms fill up with rank growths of Nettles (*Urtica*), and flowering shoots of *Lamium album*, and *Anthriscus sylvestris* with frondose foliage and stems of 3 ft., already flowering abundantly and intrusive in pastures. *Alliaria officinalis* is conspicuous everywhere near habitations; Docks (*Rumex obtusifolius*, *R. conglomeratus*) send up their leaves vertically. *Galium Aparine*, *Arum maculatum*, and locally *Chaerophyllum temulum*, *Geranium rotundifolium*, *Malva sylvestris*, add to the variety of the leafy mantle covering the rubbish of the last season. Grass shows active growth everywhere; though *Poa annua* is still the only form conspicuous in the flowering condition; the first inflorescences of *Alopecurus* and *Anthoxanthum* appear, but the flowers expand later. *Glyceria aquatica* makes rapid growth (1 ft.) in standing water and ditches; the black spikes of *Carex riparia* are conspicuous along the river-bank and intrusive in wet pastures; *Caltha* is at an optimum in flood-meadows, *Cardamine pratensis* flecks damp pastures, ditches fill up with green masses of *Callitriche verna*, *Lemna*, and floating confervoid algae, while the first aquatic *Ranunculus* (*R. Drouetii*) stars the surface of quiet and shallow water-courses and ponds.

Pastures show a dense new growth of grass completely covering the older herbage where this has been grazed, but otherwise only partially. Buttercups (*Ranunculus bulbosus*, *R. acris*) are still sparse, and the black spikes of *Plantago lanceolata* only beginning to function. Dandelions and Daisies are the most characteristic flowers, the former particularly abundant in sandy and calcareous pastures, making a brave show at 10-60-100

¹ New shoots of Elder may be already 9 in. long, *Clematis Vitalba* 6 in., *Buddleia variabilis* (in gardens) 15 in.

² Exceptional specimens of Hawthorn in cultivation are taken separately; data refers to hedge-row forms. In the University Park specimens of both *C. monogyna* and *C. Oxyacantha*, may blossom by Apr. 15 (1923). A particularly early tree in Headington Park was in full bloom by Apr. 1 (1903).

golden-yellow capitula to the square yard, the finest heads 60 mm. diam. Daisies are abundant as starring white patches in close-cropped turf, or in better drained ground, sparse at 100 per sq. yard, but attaining a maximum of 60-75 per sq. foot.

Cowslips come on locally in damp clay areas, and the Fritillary season is at its height. The maximum display of these forms is seldom greater than one flower-spike to a sq. yard. In arable fields the winter wheat is a dense smothering growth (10 in.), now rolled and tillering; beans present a dense canopy where drilled in close rows, spring oats come up thinly with an abundant series of chance seedlings. Such strong growths of wheat were formerly eaten down by sheep to promote tillering.

Sandy fields, gravel paths, and the tops of stone walls still show *Draba verna* flowering and fruiting out, with minor weeds as *Capsella*, *Cardamine hirsuta*, *Arenaria serpyllifolia*, *Saxifraga tridactylitis*, *Sisymbrium thalianum*; and, near dwellings, walls may be gay with *Senecio squalidus*, and Wallflowers.

Waste places around town and village areas, and cleared derelict ground around human habitations left from last season, now become minor gardens of weeds of human association and intrusive aliens as:—

<i>Lamium album</i> ,	<i>Lamium purpureum</i> ,	<i>Lamium amplexicaule</i> ,
<i>Plantago lanceolata</i> ,	<i>Veronica Tournefortii</i> ,	<i>Veronica hederifolia</i> ,
<i>Senecio vulgaris</i> ,	<i>Capsella Bursa-pastoris</i> ,	<i>Valerianella olitoria</i> .

Roadsides, as presenting well-drained and freely exposed stations, in addition to such forms, afford the first flowering individuals of a wide range of herbaceous types:—

<i>Lychnis dioica</i> ,	<i>Veronica Chamaedrys</i> ,	<i>Stellaria Holostea</i> ,
<i>Barbarea praecox</i> ,	<i>Sisymbrium officinale</i> ,	<i>Myosotis collina</i> .

Allotment-areas are rapidly cleared, planted and sown, with the suppression of their winter weed-flora: gardens are tidied up, massed blooms of Plum, Cherry, and Pear cover orchard areas, to be soon followed by Apple. Flower-gardens are never more brilliant and effective with their clean fresh growth and brilliantly tinted massed blossoms of Narcissus, Wallflowers, Tulips, Polyanthus, Pansies, Daisies, in many florists' forms, with *Scilla*, *Aubrietia*, *Arabis*, *Ribes*, *Berberis* (*B. Aquifolium*, *B. stenophylla*), *Doronicum*, *Kerria*, *Pyrus spectabilis*, and *Aucuba japonica*. Bees,¹ butterflies,² and flies of many sorts become general; swallows appear, skylarks sing, and in warm sunny weather the Cuckoo calls all day. With the production of the new foliage and plant-growth of all descriptions, a general tendency for spring-cleaning affects the human population; fires are let out, and the new season has obviously begun. The last week of April sees the beginning of the University Easter (Summer) Term.

In particularly late seasons the whole of these plant-phenomena are delayed into the first week of May; as, again, in early years they may be noted in the first week of April. A brief comparison of a few dates for the remarkably forward and dry warm season of 1921, the cold dry late one of 1924, and the more prevailingly mild and wet one of 1923, may be suggestive as expressing the difficulty of striking an average. The first works out at just a fortnight in advance, as others appear about a fortnight late. It may be noted that such 'first records' are open to minor errors of soil and situation, as well as that of the personal equation and non-ubiquity,³ that stragglers are general for another week, and the main crop

¹ *Bombus agrorum*, *Anthophora pilipes*, *Andrena fulva*, *Andrena albicans*, *Eristalis tenax*, *Vespa* ♀.

² Small Cabbage White, Orange Tip, Holly Blue, Brimstone.

³ To be comparable, observations should refer to the same tree, or to plants growing in the same spot in successive years.

comes on in a fortnight or so. The range between individuals growing under apparently identical conditions may be a fortnight, and the latter period of time is a convenient unit in dealing with seasonal time-factors. A miscellaneous collection of 24 plants, taken from different stations, emphasizes the general conclusions:—¹

	1921	1922	1923	1924	Range in Days.
(1) In woodland,					
<i>Pteris aquilina</i> , up.	Ap. 1	May 4	Ap. 2	May 7	36
<i>Scilla nutans</i> , first	Ap. 1	Ap. 22	Ap. 2	Ap. 21	21
" main crop	May 1st wk.	May 3rd wk.	May 1st wk.	May 3rd wk.	
<i>Orchis mascula</i>	Ap. 8	May 21	Ap. 16	May 7	43
<i>Euphorbia amygdaloides</i>	Ap. 19	May 2	Ap. 16	Ap. 28	16
<i>Anemone nemorosa</i> , opt.	Ap. 21	May 1st wk.	Ap. 15	Ap. 24	
(2) In Hedgerows,					
<i>Arum maculatum</i>	Ap. 1	May 7	Ap. 5	May 4	36
<i>Veronica Chamædrys</i>	Ap. 30	May 10	Ap. 14	May 10	26
(3) In Pasture,					
<i>Fritillaria Meleagris</i>	Ap. 1	Ap. 21	Ap. 7	Ap. 21	20
<i>Ranunculus bulbosus</i>	Ap. 12	May 2	Ap. 7	Ap. 26	25
<i>Cardamine pratensis</i>	Ap. 1	Ap. 26	Ap. 15	Ap. 28	27
<i>Caltha palustris</i> , opt.	Ap. 1st wk.	May 2nd wk.	Ap. 3rd wk.	May 1st wk.	
<i>Plantago lanceolata</i> , ♂	Ap. 18	May 6	Ap. 18	Ap. 28	18
(4) Grasses,					
<i>Anthoxanthum odoratum</i> , ♂	Ap. 22	May 8	May 4	May 3	16
<i>Alopecurus pratensis</i> , ♂	May 1	May 17	May 4	May 12	16
<i>Poa pratensis</i>	Ap. 29	May 26	May 19	May 28	29
(5) In ditches,					
<i>Carex riparia</i> , ♂	Ap. 14	May 12	May 1	May 12	28
(6) In gardens,					
Crab Apple	Ap. 7	May 6	Ap. 12	May 5	29
<i>Aquilegia vulgaris</i>	Ap. 24	May 23	May 6	May 18	29
(7) Trees,					
<i>Salix triandra</i>	Ap. 10	May 6	Ap. 14	Ap. 25	26
<i>Viburnum Lantana</i>	Ap. 28	May 16	May 3	May 10	18
<i>Crataegus monogyna</i>	Ap. 24	May 12	May 4	May 14	20
<i>Pyrus Aucuparia</i>	Ap. 30	May 17	May 1	May 12	17
<i>Aesculus Hippocastanum</i>	Ap. 14	May 8	Ap. 29	May 6	24
<i>Acer Pseudoplatanus</i>	Ap. 16	May 12	May 4	May 6	26

The fact that the University Summer Term begins in the last week of April, suggests the advantage of a general survey of the state of the flora at this time, as a standard of reference which may supply the initial material for observations during Term-time.² As a matter of convenience the working flora may be divided into sections suitable for comparison, some of which are not necessarily mutually exclusive:—

Flowering Plants (100) to April 25.

(1) Woodland Trees and Shrubs:—

<i>Betula verrucosa</i> ,	<i>Fraxinus excelsior</i> ,	<i>Pyrus Malus</i> ,*
<i>Carpinus Betulus</i> ,	<i>Salix cinerea</i> ,	<i>Salix alba</i> ,*
<i>Prunus Avium</i> ,	<i>Salix triandra</i> ,	<i>Cytisus Scoparius</i> ,*
<i>Prunus spinosa</i> ,	<i>Larix europæa</i> ,	<i>Ulex europæus</i> .

(2) Herbaceous Perennials of the Underwood and Clearings:—

<i>Mercurialis perennis</i> ,	<i>Fragaria vesca</i> ,	<i>Lamium Galeobdolon</i> ,*
<i>Primula vulgaris</i> ,	<i>Arum maculatum</i> ,*	<i>Myosotis versicolor</i> ,*
<i>Anemone nemorosa</i> ,	<i>Oxalis Acetosella</i> ,	<i>Myosotis arvensis</i> ,*

¹ The average of 24 plants, selected casually from different stations, works out as over 3 weeks (24·8); 1921 and 1923 appear as distinctly early seasons, 1922 and 1924 as conspicuously late.

² The Flora of the Summer Term.

<i>Viola hirta</i> ,	<i>Arenaria trinervia</i> ,*	<i>Euphorbia amygdaloides</i> ,
<i>Viola Riviniana</i> ,	<i>Adoxa Moschatellina</i> ,*	<i>Orchis mascula</i> ,*
<i>Viola sylvestris</i> ,	<i>Ranunculus Ficaria</i> ,	<i>Cerastium glomeratum</i> ,*
<i>Glechoma hederacea</i> ,	<i>Potentilla Fragrariastrum</i> ,	<i>Carex pilulifera</i> ,*
<i>Ajuga reptans</i> ,*	<i>Luzula pilosa</i> ,	<i>Luzula sylvatica</i> ,*
<i>Veronica serpyllifolia</i> ,*		

(3) Hedgerows and Roadsides :—

<i>Capsella Bursa-pastoris</i> ,	<i>Cardamine hirsuta</i> ,	<i>Poa annua</i> ,
<i>Alliaria officinalis</i> ,	<i>Anthriscus sylvestris</i> ,	<i>Lamium purpureum</i> ,
<i>Senecio vulgaris</i> ,	<i>Sisymbrium officinale</i> ,	<i>Lamium album</i> ,
<i>Senecio squalidus</i> ,	<i>Sisymbrium thalianum</i>	<i>Lamium amplexicaule</i>
<i>Myosotis collina</i> ,	<i>Ranunculus auricomus</i> ,	<i>Lamium incisum</i> ,*
<i>Stellaria Holostea</i> ,	<i>Lychnis dioica</i> ,*	<i>Valerianella olitoria</i> ,
<i>Viola odorata</i> ,	<i>Veronica Chamaedrys</i> ,*	<i>Reseda lutea</i> ,*
<i>Geranium Robertianum</i> ,*	<i>Barbarea vulgaris</i> ,*	<i>Symphytum officinale</i> ,*

(4) Pastures (dry, sandy, or calcareous : grazed) :—

<i>Bellis perennis</i> ,	<i>Taraxacum officinale</i> ,	<i>Saxifraga granulata</i> ,*
<i>Plantago lanceolata</i> ,	<i>Luzula campestris</i> ,	<i>Cerastium vulgatum</i> ,
<i>Carex praecox</i> ,	<i>Ranunculus bulbosus</i> ,	<i>Trifolium minus</i> ,*
<i>Tussilago Farfara</i> ,	<i>Ranunculus acris</i> ,*	

(5) Meadows and Damp Alluvium :—

<i>Primula veris</i> ,	<i>Cardamine pratensis</i> ,	<i>Fritillaria Meleagris</i> ,
<i>Carex glauca</i> ,*		

(6) Swamp-Woodland :—

<i>Callia palustris</i> ,	<i>Petasites officinalis</i> ,	<i>Montia fontana</i> ,*
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(7) Sub-aquatics of Ditch and River-bank :—

<i>Ranunculus Drouetii</i> ,	<i>Carex riparia</i> ,*
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(8) Aquatics of Open water :—

(9) Cultivated Fields and Allotments :—

<i>Veronica Tournefortii</i> ,	<i>Stellaria media</i> ,	<i>Urtica urens</i> ,
<i>Veronica hederifolia</i> ,	<i>Viola arvensis</i> ,	<i>Sinapis arvensis</i> ,*
<i>Veronica agrestis</i> ,*	<i>Medicago lupulina</i> ,*	<i>Erodium cicutarium</i> ,
<i>Raphanus Raphanistrum</i> ,*	<i>Scleranthus annuus</i> ,*	<i>Sherardia arvensis</i> ,*
<i>Brassica oleracea</i> * (forms),	<i>Brassica campestris</i> (forms),	

(10) On Wall-tops :—

<i>Draba verna</i> ,	<i>Arenaria serpyllifolia</i> ,	<i>Saxifraga tridactylites</i> ,
<i>Linaria Cymbalaria</i> ,	(<i>Cheiranthus Cheiri</i>).	

(11) Flowering Trees and Shrubs of Garden-cultivation :—

<i>Pyrus Malus</i> (hort.),	<i>Viburnum Tinus</i> ,	<i>Ribes sanguineum</i> ,
<i>Prunus Cerasus</i> ,	<i>Berberis Aquifolium</i> ,	<i>Ribes Grossularia</i> ,
<i>Pyrus communis</i> ,	<i>Prunus Lauro-cerasus</i> ,*	<i>Ribes nigrum</i> ,
<i>Pyrus spectabilis</i> ,*	<i>Berberis stenophylla</i> ,*	<i>Ribes rubrum</i> ,
<i>Cydonia japonica</i> ,	<i>Choisya ternata</i> ,*	<i>Ribes aureum</i> ,*
<i>Clematis montana</i> ,*	<i>Kerria japonica</i> ,*	<i>Daphne pontica</i> ,
<i>Syringa vulgaris</i> ,*	<i>Laurus nobilis</i> ,*	<i>Rosmarinus officinale</i> ,
<i>Ceanothus rigidus</i> ,	<i>Aucuba japonica</i> ,*	<i>Buxus sempervirens</i> ,*
<i>Prunus communis</i> ,	<i>Amelanchier vulgaris</i> ,	<i>Rhododendron</i> (hybrids).

(12) Trees flowered out or fruiting :—

<i>Alnus glutinosa</i> ,	<i>Salix caprea</i> ,	<i>Prunus insititia</i> ,*
<i>Corylus Avellana</i> ,	<i>Salix purpurea</i> ,*	<i>Taxus baccata</i> ,

(<i>Ulmus campestris</i>), ¹	(<i>Populus nigra</i>),	<i>Thuya gigantea</i> ,
<i>Ulmus montana</i> ,	(<i>Populus serotina</i>),*	<i>Biota orientalis</i> ,
(<i>Ulmus vegeta</i>),	(<i>Populus candicans</i>),*	<i>Daphne Laureola</i> ,
<i>Populus tremula</i> ,	<i>Cupressus Lawsoniana</i> ,	<i>Viscum album</i> .

Omitting the last two headings, this leaves a convenient schedule of just 100 flowering forms which may be checked in ecological groups. The later names in each section indicate the more casual and later comers, as at this critical time a single day may add half a dozen forms to the phænological list. In particularly late seasons many may be wanting. An asterisk is used to mark some 40 which were not up to time on the first day of the Summer Term (April 28) 1924;² while in exceptionally early seasons (1921) the list may be considerably extended.

The weed flora is still scanty, as the new season's annuals are not yet in possession. Roadsides, with well-drained and sheltered or sun-warmed spots, present a precocious flora of forms belonging to other stations. Woodland trees are largely over, and flowering grasses are conspicuously wanting, as also are full aquatics.

IV. THE FULFILMENT OF SPRING.

In spite of the traditional May-day, which now falls nearer the middle of the month (May 12-14), the beginning of May is more commonly chilly and bleak, with an April temperature nearer 50° F. than 60°, and the possibility of night frosts. But the conditions greatly improve towards the middle of the month to typical May weather, as the optimum growing season of the year. The hours of available sunlight increase from 14½ at May 1 to 16 at the end of the month. The sun rises at half-past four a.m., May 1, and sets at 7.20 p.m. (or as we agree to call it 5.30 a.m. and 8.20 p.m. 'summer-time'). Even allowing for the general average of 60% of total daylight as dull and cloudy, the increasing hours of daylight give a greater range of hours of bright sunshine, to 193.3 (average of 40 years), and a record of 293.6 (1909) as the sunniest month. The minimum recorded is 119.8 (1889).³

With rain-fall at its monthly average of about 2 inches (average of 70 years 1.973), sunshine at an optimum, and the possibility of rising temperature at an optimum for the North Temperate—mean maximum 61.8°, mean minimum 44.11°, and extreme range from 85.6° (May 23, 1922) to 20.4° (1892)—all plant-growth comes on with greatest rapidity; and it is the sudden rush of rank green growth in field and woodland that gives the characteristic feature of the period. The whole landscape shows a blend of the softest and brightest tints of new green shoots. Hedgerows and pastures become uniformly and densely green, while flowers begin to give a conspicuous effect on all sides, with an output which is not surpassed at any other time of the year.

The season is still subject to reversions to cold conditions. Dry N. and NE. winds at a day's notice may bring a sudden fall of temperature of 20° F. or more, with night frosts whitening the ground in early morning (six or seven degrees), and things again remain stationary for a week or more at a time; the fine weather being usually only regained through a period of cold rain with further chilling effects. Hence in early May cold and wet spells are frequent, but the average of the season remains little affected, and the middle of the month presents pre-eminently the

¹ Brackets here indicate forms which do not produce seed: otherwise brackets are used to mark the casual escapes of cultivation.

² And about a dozen had not been checked by May 12.

³ Radcliffe Observatory Reports, LII, p. 113.

spring season for the central part of the country. Bearing in mind the alteration in the calendar, it may be noted that this optimum spring season coincides very fairly with 'Old May-day', in which the phenomena are popularly centred.¹ The period may be also well-defined as 'Cuckoo-time'; in mild weather the Cuckoo is heard in the open country calling all the day; though in cold spells it may be entirely mute: as in fact it is not heard to call until the real spring rise of temperature has been attained in April. Hence several familiar flowers have been associated with Cuckoo-time which exactly covers this optimum period as 'Cuckoo-flowers': cf. *Cardamine pratensis* of the meadows, *Arum maculatum* (Cuckoo-pint) of shady hedgerows, *Lychnis Flos-cuculi* of damp-pastures.²

With no other plant has the English May been so closely connected traditionally, as with the flowering period of the Hedgerow Hawthorn (*Crataegus monogyna*) or 'May', the hardiest tree of the countryside, in underwood, or dry open clearings, the first tree to establish itself in regressive thorn-scrub, and above all so conspicuously increased by human association as the typical *hedge-plant*, that its predominance in hedgerows with massed white blossoms often concealing the foliage, is the first striking feature of the green spring landscape. Hence the May period is essentially 'Hawthorn-time', and the first flowering indicates the fulfilment of Spring; both the foliage and flowers of all other indigenous spring-flowering trees being then well-advanced, and the hedges and underwood definitely green.³ The flowering period covers about 3 weeks, and in normal seasons the plants are coming into bloom in the first week of May; that is to say, when any Hedge Hawthorn is in blossom on the first of May, the season is distinctly an advanced one: though in exceptionally early seasons it may be out in the third week of April, as in latest seasons it may not break out until the third week of May. Hence the date of Old May-day fairly averages up the most reliable time.⁴

In hedgerows whitened with Hawthorn, often closely associated with the last flowering straggling branches of the Blackthorn (*Prunus spinosa*),

¹ Old May-day is now May 14. In the late spring of 1924, the first really faultless day of the month was May 28, the last day of the Eights: no night frost⁵; no rain, no heavy wind; blue sky, mild breeze, hot sun all day, all trees green and heavy with new foliage, meadows yellow with buttercups, hawthorn heavy with flowers and scent, grass growing rank and river full.

² The association is as much continental as English. After intensely sunny days, with a bright moon, clear sky, and abundant white orchard-bloom, the cuckoo was recorded as calling for an hour at midnight (summer-time, May 12, 1922). The favourable combination of climatic conditions of temperature, water-supply, with renewed plant and associated insect-growth, induces many migrant birds to come North for the nesting period. In this respect the important factor is the abbreviated night-period, reducing possibly to 6-5 hours the hunger-period of the hours of darkness, beyond the possibilities of a more southern climate, and thus enabling many birds to successfully feed and rear their young.

³ All fruit-trees including Apple and Wild Crab are out before the Hawthorn, and the Horse Chestnut normally so. Lilacs and Laburnums of the garden are practically simultaneous, and are hence also popularly indicated as 'May'. This refers to the common Hawthorns of the field-hedges and woodland. Particularly early forms may be found in cultivation, and in Park-ground individual trees of *C. monogyna* and *C. oxyacantha* break into flower simultaneously side by side.

⁴ In a late season (1922) an early tree in Headington Park was going out of bloom May 20, when there was practically no blossom in hedgerows, having been in flower from May 1: in 1903 this tree was in full bloom on April 1. In the late season of 1924 Hedge Hawthorn first broke out May 13, was at an optimum only on May 31, and all gone by June 15.

Following the drought of 1921, Hedge Hawthorn in 1922 gave an exceptionally spectacular effect, but did not culminate till May 25, going off rapidly after June 1, and leaving no trace of flower by June 10. Long stretches of hedgerow, whitened as if by snowfall, were conspicuous at a distance of 4 miles across the Thames Valley; fruit-production was also phenomenal; ranges of hedge showing deep red with berries after the fall of the leaf (November), and isolated bushes coral-red in the sun over the winter. Much of the fruit was still on when the foliage and flowers broke out in 1923, but the plants having been exhausted gave an extremely scanty display. Even in 1924 recovery was by no means general.

⁵ The traditional value ascribed to March dust finds a parallel in properties associated with May dew, as warm and clear nights give the first heavy dews which are no longer white frosts.

minge the blossoms of the Wild Crab (*Pyrus Malus*), and in woodland those of *Viburnum Lantana* (the Wayfaring Tree).¹ Planted garden-flowers, Lilacs, Laburnums, with Wistaria, Choisya, *Pyrus spectabilis*, also dominate the month, and the main crop of Rosaceous trees of garden and orchard (more especially the Apple), late Pears, Cherries (single and double, white and pink), and among planted trees the Horse-chestnuts, the less conspicuous Sycamore (*Acer Pseudoplatanus*), the later Willows (*Salix alba*), the Mountain Ash (*Pyrus Aucuparia*), and finally the Guelder Rose (*Viburnum Opulus*). No time of the year is more spectacularly floriferous, and the last weeks of the month show the countryside at its best. The last week of May marks the time of the Summer Eights, and commonly includes Whitsuntide; under such stimuli a district long derelict over the dull winter season, wakes to new life for a short period of intensive plant-growth.

Plants, like ourselves, exist under the immutable law which says that a type which will not do its legitimate work in providing for the continuation of its particular line of the stream of living organization, dies out. The struggle for existence is not so much the story of the individual's struggle to maintain its own life, as the expression of the work to be done in maintaining its particular branch of the race by reproducing in quantity sufficient to counterbalance the inevitable wastage of natural selection. In this the conservation of the life of the individual is only important so long as it is capable of reproduction and of providing for the new units. Every plant and animal at present living on the world's surface is the direct inheritor of untold millions of generations of organism, all of which have done their duty in this respect. All duds go, involving with their elimination also much of any incipient tendency to be such a failure; yet any one may become a dead end by design or accident of blind chance which men call fate. Hence in the flowering *en masse* of the spring vegetation, which is the expression of the reproductive pressure of these strange organisms—in many respects so remote from our own perception of living action, and separated by an evolutionary period of divergence only to be expressed in thousands of millions of years—where some see only the glory of the Spring, others are more impressed by its pathos, as again visualizing the parallel wastage of human activity and forethought, similarly exposed to indefinite chances of accident, and necessitating so vast an outlay of individual effort on the vaguest hope of maintaining racial continuation, quite apart from any question of improvement.

As already emphasized, the essential botanical feature of the month is not so much the free production of flowers, largely left over from the preceding Autumn, on the part of the vegetation of a short Northern season, as the full renewal of the canopy of the woodland closing in over the woodland base. The first effect on the landscape is seen more particularly in the filling up of the hedgerows with dense tree-growth (mostly Elms) and bottom shrub-vegetation, increasing the apparently wooded aspect of the countryside, as green hedgerows block out the distant view. With the welcome rise in temperature, intense insolation, and long days, all plant-growth comes on with such a rush that it is difficult to keep up with it; and one sees how quickly an observer may be overtaken, and with the best intentions is apt to deteriorate into a mere collector, as new plants are checked each day faster than they can be followed in any detail. The May schedule adds some 125 flowering plants to the working plan.

¹ Along wooded rides lacking artificial hedgerows, flowering *Viburnum Lantana* is abundant and more characteristic than the Hawthorn, thus lending significance to its older name of 'Wayfaring Tree'.

Under such conditions, plant-life and associated animal life are equally at an optimum, and the feelings of the human population, essentially a race of the more temperate regions, run very parallel with the renewal of the flora.¹ Ancient customs of welcoming May Day with floral garlands, once spontaneous on the part of children, and expressed in the wealth of available wild flowers, tend to be revived under modern 'back to nature' schemes of a town-bred population. Countryside garlands of Buttercups, Daisies, Celandines, Bluebells (*Scilla*), *Orchis mascula* (Long Purples of Shakespeare), King-cups (*Caltha*), Lady's Smock (*Cardamine pratensis*), Fritillaries (Snakes' Heads), are eked out with garden Wallflowers, blue Myosotis, Polyanthus, Tulips, Cornish Daffodils and Narcissi of the shops, and even Arum lilies (*Richardia*) of the greenhouse and S. Africa.

The full effect is well-marked in all departments of the flora. In woodland the high canopy begins to fill up with new foliage, and externally the forest again appears clothed in green; the majority of trees being now in full leaf, though a few forms conspicuously lag behind. Thus the Oak shows a wide range from individuals in practically full leaf and functional activity, to others in which the buds are only just breaking out: flowering trees are usually ahead of the sterile. The Ash, though flowered out, is still only breaking its leafy buds, though the foliage of coppice-growth may be well advanced. Huntingdon Elms and Wych Elm, when bearing a heavy crop of samaras may be conspicuously behind the Common Elm, the latter leafing to the top before the others break. The green samaras are drifted by the same winds which drift the stipules of the Limes and the bud-scales of the Beech. Other conspicuously late trees include planted forms as *Populus serotina* and the Planes, as also alien forms of garden-cultivation as *Robinia Pseudacacia*, *Ailanthus*, *Juglans*, the Fig, Vine, and Sumach: in particularly late seasons many of these may be still bare or thinly clad in mid-June.² Among the underwood trees Crab Apple, *Viburnum Lantana*, and the Mountain Ash (planted) are flowering freely before the Hawthorn reaches its maximum display; *Ulex* is still in full colour on heathy waste, and the Broom is at its optimum on dry sandy tracts (Cumnor Hurst).

With this final renewal of full leaf-canopy, the flowering capacity of the woodland base diminishes. *Mercurialis* flowers and fruits in the shade, and *Scilla* becomes dominant, more particularly in open clearings. In the shade of close coppice (Hazel), stray Primroses, Celandines, and Violets, may be delayed for a week or two; but when these flower out they are not replaced. Rapid new growth of Bracken covers much of the wooded areas where light still penetrates, especially under low-crowned spreading Oaks, growing a foot a fortnight until Midsummer (6 ft.), though in open situations it is still subject to destruction by late frosts.

Similarly, taking the first blossoms of the Hawthorn as a guide to the great break of May flowers, it is interesting to compare the forms dominant at this period with those of the previous month, as marking one of the most clearly defined epochs of the annual succession. The first spectacular feature of the more open clearings and forest-plots is the display of Bluebells (*Scilla nutans*), which overshadows all else in the woodland base. Bluebells

¹ Through long ages the human population is necessarily imitative of its local environment, and colour begins to play a more conspicuous part in personal decoration and sartorial embellishment, as again a general cleaning up and decoration of public and domestic premises follows the similar burst of activity on the part of the dominant flora.

² Following exceptionally cold and unfavourable conditions of a springless year (1923), many trees (*Robinia*, *Ailanthus*, *Ginkgo*) were affected by late frosts and practically leafless, only breaking into full leaf in the first week of July (*Fig*, *Gymnocladus*); and thus only functional after June 21, and on the descending portion of the light-curve.

are everywhere, scattered thinly, or giving broad patches and seas of vivid blue, with the effect of pools of blue fire, as a colour display not surpassed by any other indigenous or cultivated plant.¹

Bluebells follow Wood Anemones as commonly associated with Bracken, flowering out before the Bracken is able to cover them, though it comes up at the same time, growing 1-2 ft. high. Bluebells are at an optimum in open clearings, especially where the Bracken has not yet recovered from the shading of the coppice; but they also endure shade where no Bracken will grow. Residual Scillas are among the last denizens of ground under Larch (forest-plots at 4 ft.), and apparently survive a cycle of the rotation. They do best on well-drained Plateau Gravel (Bagley), Calcareous Grit (Stow Wood), Portland Beds (Bluebell Valley, Horspath), Greensand (Hen Wood), but are distinctly poor and small on clays. In damper areas *Mercurialis* and even Nettles may become dominant.

In recent years a remarkable display has been given at Middle Hill (Bagley Wood), under several acres of full-grown Sycamore coppice (30 ft. poles), in the shade of which no other plants beyond a few Anemones can grow (except Bracken under residual open-crowned Oaks). This area gives flower-spikes at 200 to the sq. yard. The floral display is increased on felling (240 per sq. yd.), and in open clearings during the first years of regeneration the maximum attained was 320 spikes per sq. yd. flowering simultaneously: under sparse Oak standards, with Bracken sub-dominant 160 per sq. yd.: under 30 ft. Larch, close-planted, patches of etiolated plants gave 50 spikes to the sq. yd.: among *Mercurialis* on calcareous tracts in close cover and shade, reducing to 1 per sq. yd.

The flowering period is at an optimum in the first week of May (1921, 1923) ranging to the third week (1922, 1924) in late seasons; and, as in the case of the Hawthorn, is hastened by a spell of great heat. The flowers are visited by Humble Bees (*Bombus lapidarius*, *B. terrestris*, *B. agrorum*), by many flies taking pollen (Syrphidae), White Butterflies, and by Hive-bees; the last taking honey illicitly from older flowers by probing between the bases of the perianth-segments. The flowers give a distinctly fragrant scent, and the pollen-supply is sufficient to dust one's boots yellow in walking through them. The display of blossom is remarkably simultaneous, and as the spikes flower out and elongate, the full effect is only seen for 2-3 weeks: the last strays may be found in mid-June. The fruits ripen in July, when all overground parts disappear, though in damp shade green capsules persist over August.

The predominant Primroses, Celandines, Violets, and Anemones of April are now left as relics only, but clearings and recently planted forest-plots (Bagley) are still abundantly floriferous; the predominant flowers being conspicuously blue, comprising Bluebells and massed—

<i>Ajuga reptans</i> ,	<i>Veronica Chamaedrys</i> ,	<i>Glechoma hederacea</i> ,
<i>Viola Riviniana</i> ,	<i>Myosotis arvensis</i> ,	<i>Veronica Beccabunga</i> , ²

with more scattered—

<i>Orchis mascula</i> ,	<i>Cardamine pratensis</i> ,	<i>Fragraria vesca</i> ,
<i>Veronica serpyllifolia</i> ,	<i>Lamium Galeobdolon</i> ,	<i>Stellaria Holostea</i> ,
<i>Anthoxanthum odoratum</i> ,	<i>Rumex Acetosella</i> ,	<i>Luzula pilosa</i> ,
<i>Senecio sylvatica</i> ,		

and intrusives, as—

<i>Crepis taraxacifolia</i> ,	<i>Geranium molle</i> ,	<i>Senecio squalidus</i> ,
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¹ Nor again in primary tropical forest (A. Russel Wallace, 1851). Wallace states that he had never seen anything in his travels on the Amazon to equal the beauty of an old Crab Tree in full bloom, or a glade of Bluebells.

² The last in drainage-ditches: *Ajuga* may give patches with 50 spikes to the sq. yard. In hot weather following rain the rapid decay of the dead Bracken mass of the previous season is very marked; the main stems remaining last, and leaving the ground comparatively bare for the vegetation of Anemone leaves and *Scilla*, before the new green fronds make good their new canopy in early June.

In older woodland¹ rides and glades, characteristic forms appear—

<i>Listera ovata</i> ,	<i>Euphorbia amygdaloides</i> ,	<i>Carex sylvatica</i> ,
<i>Cerastium glomeratum</i> ,	<i>Veronica officinalis</i> ,	<i>Luzula sylvatica</i> ,
<i>Potentilla Tormentilla</i> ,	<i>Cardamine flexuosa</i> ,	<i>Melica nutans</i> ,
<i>Aquilegia vulgaris</i> ,	<i>Lysimachia nemorum</i> ,	<i>Ranunculus auricomus</i> ,
<i>Allium ursinum</i> ,	<i>Arum maculatum</i> ,	<i>Vicia sepium</i> ;

in damper stations *Carex pendula*, grading to more definitely swamp-woodland,² in which *Caltha* may remain in its original habitat, with forms as—

<i>Valeriana dioica</i> ,	<i>Paris quadrifolia</i> ,	<i>Carex pulicaris</i> ,
<i>Schoenus nigricans</i> ,	<i>Viola palustris</i> ,	<i>Carex paniculata</i> .

Hedge-banks present their characteristic new under-flora, at an optimum beneath Hawthorn, Crab and Willow, still fresh and undefiled by the dust of the roadside. Familiar near human habitations are—*Lamium album* conspicuously predominant, *Alliaria officinalis* (2-3 ft.), and the ubiquitous Keck (*Anthriscus sylvestris*, 3-4 ft.) with rank frondose leaves and drooping young inflorescence-axes. Yellow Buttercups, white Stitchwort (*Stellaria Holostea*), Red Campion (*Lychnis dioica*), and blue Speedwell (*Veronica Chamaedrys*), give the colour-scheme, with minor and more casual forms—

<i>Barbarea vulgaris</i> ,	<i>Geranium pyrenaicum</i> ,	<i>Geranium molle</i> ,
<i>Myosotis arvensis</i> ,	<i>Geranium Robertianum</i> ,	<i>Geranium dissectum</i> ,
<i>Galium Aparine</i> ,	<i>Geum urbanum</i> ,	<i>Chaerophyllum temulum</i> ;

the last of these are again but the advance-guard of the succeeding month. Dense growths of Nettles (2 ft.), Docks (2 ft.), and climbing Hop-shoots (5 ft.), *Bryonia* (3 ft.), *Galium Aparine* (2-3 ft.), and the foliage of the Keck cover everything below the shrub-level, together with rank grasses (*Poa pratensis*, *Bromus sterilis*, *Bromus mollis*) rapidly coming on, with the ubiquitous *Poa annua* still at its optimum.

Special interest attaches to active growth in pastures; the grass bottom becomes dense, and the crop rapidly rises beyond the capacity of the Daisies³ and Dandelions⁴ to follow. With the flowering of the Hawthorns the main crop of Dandelions is over, and the fruits begin to clock out (50 mm. diam.), again often simultaneously and with spectacular effect on calcareous soils. Similarly conspicuous in the fruiting stage are now *Tussilago Farfara* and the earliest crop of *Senecio vulgaris*. Permanent pastures become yellow with Buttercups: *Ranunculus bulbosus* on gravel areas gives golden expanses; 300 blooms to the sq. yard being a good display. In clay areas *Ranunculus acris* is dominant, as also on alluvium; and as a tall branching form keeps pace with the crop, growing 2 ft. or more, 10-20 axes to the sq. yard, each of which may produce 5-16 functional flowers simultaneously. *R. repens* is later (June) and is characteristic of damp hedge-bottoms, waste places, as a weed of human association. All these Buttercups are again enormously increased by human agency, as adapted to the artificial conditions of the pasture field and hay-crop. *Anthoxanthum odoratum* (Sweet-scented Vernal) is the

¹ Bagley Wood, Stow Wood, Wick Copse.

² Headington Wick.

³ Daisies give white stretches in grass fields at 50 capitula to the sq. ft., and in open grassland attain a maximum of 70-150 per sq. ft.; but an effective display in pastures is given with the smaller number of well-grown inflorescences.

⁴ Dandelions (*Taraxacum officinale*), particularly striking in April as the predominant flower of calcareous pastures, flowering out before the Buttercups and *Plantago* of May, increases from 10 capitula per sq. yard to 50-60, towards the end of the month (max. 67); at this rate they give golden stretches in pastures as the capitula expand in full sunshine, and such fields may be conspicuous at a distance of 2-3 miles (Lye Hill, 1922). The number of capitula actually produced is much greater, and is best realized when the fruiting heads begin to clock out in early May.

first pasture-grass to bloom, and broad stretches of grassland are soon bronzed with its young flower-spikes. This is followed by *Alopecurus pratensis* (Meadow Foxtail), and a little later by *Poa pratensis* and *Bromus mollis* as the first grasses of the main crop; but it may be noted that the characteristic inflorescences of grasses are recognizable as they are slipped from the sheathing leaf-base often for 2-3 weeks before the flowers open or display their anthers. Many June forms thus come on in the latter part of May (*Dactylis*, *Festuca* (sp.)). With the grasses other flowering plants are associated, more especially *Plantago lanceolata*, with 100-225 flowering spikes to a sq. yard, and often equally abundant—

<i>Trifolium pratense</i> ,	<i>Medicago lupulina</i> ,	<i>Chrysanthemum Leucanthemum</i>
<i>Trifolium minus</i> ,	<i>Rhinanthus Crista-galli</i> ,	<i>mun</i> ,
<i>Vicia hirsuta</i> ,	<i>Rumex Acetosa</i> ,	<i>Crepis taraxacifolia</i> ,
<i>Vicia angustifolia</i> ,	<i>Veronica Chamaedrys</i> ,	<i>Tragopogon pratense</i> .

Calcareous pastures give *Saxifraga granulata*, damper levels Cowslips and associated *Orchis Morio*: locally *Pedicularis sylvatica* and *Geum rivale*. *Ajuga reptans* may be intrusive from woodland; and in damp alluvial pastures appear intrusives from swamp, as *Senecio aquaticus*, *Lychnis Flos-cuculi* and many Carices (*C. glauca*, *C. acuta*, *C. panicea*, *C. hirta*, *C. disticha*, *C. riparia*). Pasture-fields which have been trampled by footballers during the winter soon become gardens of flowers, 6 in. to 1½ ft. high, giving golden expanses of Buttercups, mingled with purple Clover, white Ox-eye Daisies, pink *Lychnis Flos-cuculi*, blue Speedwell and rusty-red Sorrel (*Rumex Acetosa*); the popular names again expressing their age-long familiarity and abundance.

Ditches fill up with characteristic new erect foliage-shoots of *Glyceria aquatica*, new leafy stems of *Phragmites* among the wreckage of the previous season, together with *Carex riparia* showing yellow brushes of anthers and *Carex paludosa* with short pointed black spikes. The first lilac inflorescences of *Hottonia* appear at the surface; quiet streams fill with masses of *Callitriche stagnalis*, *Lemna* forms a new mantle-growth, while ponds and shallow water-courses are starred and whitened with the small blossoms of the first Water Ranunculus (*R. Drouetii*).¹ River-bank and ditch-side afford pale-yellow *Symphytum officinale*, to be soon followed by early sub-aquatics—

<i>Cardamine amara</i> ,	<i>Thalictrum flavum</i> ,	<i>Stellaria glauca</i> ,
<i>Myosotis palustris</i> ,	<i>Senecio aquaticus</i> ,	<i>Menyanthes trifoliata</i> .

Wall-vegetation includes—

<i>Linaria Cymbalaria</i> ,	(<i>Centranthus ruber</i>),
<i>Senecio squalidus</i> ,	<i>Valeriana olitoria</i> ;

and exposed tops carry a reduced growth of *Arenaria serpyllifolia* and *Saxifraga tridactylites*,² following the fruiting out of *Draba verna*.

In arable fields the wheat is getting thin below as it tillers, and winter-sown beans are flowering *en masse*, with a weed-crop coming on beneath them. In open uncultivated fields the weed-flora, in addition to any intrusive pasture-plants, already includes a varied assortment of the casuals of cultivation—

<i>Scandix Pecten-Veneris</i> ,	<i>Lithospermum arvense</i> ,	<i>Papaver Argemone</i> ,
<i>Sherardia arvensis</i> ,	<i>Erodium cicutarium</i> ,	<i>Capsella Bursa-pastoris</i> ,
<i>Trifolium incarnatum</i> ,	<i>Fumaria officinalis</i> ,	<i>Alopecurus agrestis</i> ,
<i>Spergula arvensis</i> ,	<i>Sonchus oleracea</i> ,	<i>Lepidium sativum</i> ,
<i>Cerastium arvense</i> ,	(<i>Symphytum orientale</i>),	(<i>Secale cereale</i>);

¹ Port Meadow.

² Reducing to miniature plants, ½ in. high, with only a single terminal flower.

in sandy tracts *Myosotis collina* and *Sisymbrium Thalianum* may be so preponderant as to tint broad areas; *Sinapis arvensis* (Charlock) and *Raphanus culminate* later.

In addition to the common fruit-trees of orchard and garden, decorative shrubs and small trees flower in abundance with the Lilacs and Laburnums, the last blossoms of *Viburnum Tinus* and *Cydonia japonica*, with *Kerria japonica* (single and double), Wistaria, Choisya, Weigelia, Cotoneaster (sp.), *Clematis montana* and *Pyrus spectabilis* (single and double). Cottage gardens display a mass of bloom,¹ and in allotments seedlings are rapidly growing; early Broad Beans are in flower, and any derelict areas left still untilled become an obvious eyesore and public nuisance, with dense covering growth of all the commoner weeds²—

<i>Capsella Bursa-pastoris</i> ,	<i>Cardamine hirsuta</i> ,	<i>Veronica hederæfolia</i> ,
<i>Veronica Tournefortii</i> ,	<i>Senecio squalidus</i> ,	<i>Stellaria media</i> ,

Lamium (sp.), Dandelions, Groundsel, &c.: pale-yellow masses of flowering Cabbage and Sprouting Broccoli (*Brassica oleracea*, forms), may become a feature in the suburban landscape.

While the optimum flowering-period of the Hawthorn sees the Bluebells getting over in the woodland base, and the alluvial pastures becoming increasingly golden with Buttercups, the most noteworthy of the contemporaries of *Crataegus monogyna* around human habitations is the common Keck³ (Cow Parsley, *Anthriscus sylvestris*), the massed growths of which fill the hedge-bottoms and ditches below the Hawthorn level, and extend into pastures, particularly in the shade of larger trees, but also into open grassland where this is not much grazed, to 50 yards or more, and again along roadsides wherever the ground has been disturbed, at the rate of about 10 fine branched plants to the square yard. The long hedge-ranges and broad tracts of this plant give a characteristic appearance to the landscape, more especially around urban areas; even the most squalid back-ways and village tenements are temporarily veiled and beautified by the graceful lace-work of slender stems (3–4 ft.) and frond-like foliage (1 ft.) which rapidly conceal everything under a mass of delicate white waving umbels (3 in. diam.). The plant is essentially a human associate; it does not penetrate the woodland except as the merest marginal intrusive. The small flowers are not in themselves conspicuously beautiful; they possess no scent, and the shoots rapidly flag when gathered; their interest is that of a small generalized, fly-pollinated type of Umbellifer, with abundant succession of new branches and flowering laterals; but their vast predominance and the elegance of the slender girder-work of the shoot-system render them extremely effective.

The graceful dominance of the Keck lasts similarly for 2–3 weeks, as it rapidly flowers out to a straggling mass of untidy wiry fruiting stems, draining the radical leaves; and with it the clean beauty of the spring

¹ Colour-forms of Wallflower, Polyanthus, *Iris germanica*; bulbous forms as Scilla and especially Tulips, *Narcissus poeticus*; herbaceous forms as *Arabis*, *Alyssum*, *Aubrietia*, *Asperula odorata*, London Pride (*Saxifraga umbrosa*), Pansies, Violas, Daisies (*flore pleno*), *Myosotis* in variety; Paeonies, Columbines, *Lunaria biennis*, *Hesperis matronalis*, *Doronicum plantagineum*, *Clematis montana*.

² This is now an offence punishable by a fine (1924).

³ Keck is the Warwickshire name for this familiar plant, and the flowering of the Keck has been always one of the most striking features of the district. It was familiar to Shakespeare (*Tempest*) and the name is retained as more expressive than the colourless 'Hedge' or 'Cow Parsley'. Locally it is more generally known as 'Cow Parsley', and the term Keck applied to the later and larger *Heracleum Sphondylium*. The plant is eaten by cattle and by rabbits, and has been used as a pot-herb; this probably explaining its human association. Denuded hedgerows soon fill up with it, and small paddocks may be covered with its waving masses, to be cut down as a nuisance with hook.



9. Crab Apple and Bluebells in Oak Woodland ; Milestone Piece, Bagley ;
May 20, 1922.



10. Meadow Hay; Buttercups (*Ranunculus acris*) and Hawthorn Hedge; Ifley Turn, May 27, 1922.

begins to go off. The essential feature of the season has been that so far there has been no conspicuously worn-out plant-growth; everything is fresh and green; active new growth rapidly conceals the early spring forms, and exhausted *Draba verna* is not present in quantity sufficient to be conspicuous with the untidy effect which is given the hedge-bottoms of urban roads by the fruiting out of Keck, *Capsella*, *Alliaria* and coarse grasses as *Bromus sterilis*.

With the passing of the whitened hedgerows, the fading out of the Bluebells in the underwood, to be followed by the Keck of the hedge-bottoms and the Buttercups of the pastures, the maximum flowering period of the early spring passes its zenith; and though many other types come on, the general aspect is not maintained by the indigenous flora; spectacular effects in the open being due henceforward to alien weeds of cultivation, as Charlock, Poppies, and *Raphanus* of more agricultural association.

Eights Week. The fourth week of May, which marks the middle of the University Summer Term, commonly overlaps Eights week, as the time which more than any other period expresses the culmination of the Spring. 'Oxford is Oxford most when May is May.' May 24 (Empire Day) may be taken as an empirical date which averages this season in successive years, again often approximating Whitsuntide when Easter falls early. This period plays so important a part in University life that it may be convenient to summarize the general state of the flora at this time. The great burst of Spring flowers is over; trees are predominantly flushed in green foliage, pastures are deep in growing grass, and all the debris of the past winter in field and woodland, ditch and river-bank, is now hidden by the rank growth of new vegetation. Long days, bright sun, and a more grateful temperature become the rule.

In woodland the trees show full canopy, though some Oaks and Ash may be still delayed. Spruce and Fir are decked with fresh green shoots, though *Pinus sylvestris* is only flowering on new silvery growths. None of the larger trees are now in bloom; the Oak is going over, though minor trees of the underwood (Holly, *Euonymus*, *Viburnum Lantana*, *V. Opulus*) continue. Fruit-trees are green with leaf and are setting fruit. Planted *Aesculus* (white and pink) are still flowering freely; Laburnums, white and pink Thorns are abundant in garden and Park-ground. In late seasons Hedge Hawthorn is still at its best, and as it goes the first blossoms of the Elder appear. The first *Salix caprea* is already shedding fluffy seeds, and in time of drought even the first yellowing leaves of pollard Willows begin to fall away as the indication that Spring is over.

In the woodland base Ferns (*Aspidium* and *Lastraea dilatata*) attain full frond-growth (4-5 ft.); the Bracken is pushing 3-4 ft. with fronds still soft and unfolding above. Brambles are green with new shoots; grasses grow rank, but the flowering of the woodland is over, merest relics of Primroses, Celandines, and even Bluebells and *Orchis mascula* may remain, but the floral display now centres in *Ajuga*, Sanicle, *Fragraria vesca*, *Veronica Chamaedrys*, and a miscellaneous mixture of minor forms. The clearings and forest-plots show a dense carpet of herbaceous plants in closest competition; but grasses become more dominant in older stages, and the floral display no longer tints broad areas.

Hedges fill up with Hawthorn blossom; *Anthriscus* (Keck) is dominant by roadsides in all hedgerow waste; the first strays of the summer flora begin to appear; grasses cover up all interspaces; though these are not yet flowering freely, the panicles are pushing in abundance; *Draba* is still flowering and fruiting freely on gravel paths.

The pastures are thick with grass; Dandelions and Daisies are buried

in the thick bottom-growth: Buttercups are dominant, and whole tracts of alluvial meadows are yellow stretches of *Ranunculus acris*. Purple Clover (*Trifolium pratense*) and white Ox-eye Daisies add to the display, with dull red *Rumex Acetosa*, intrusive *Anthriscus sylvestris*, and the first flowering grasses (*Alopecurus pratensis*, *Anthoxanthum*, *Poa pratensis*, *Bromus mollis*). Fritillaries are wholly gone, a fortnight since. Bean-fields are flowering out; many are yellow with Charlock; the weed-flora still consists largely of casuals and strays. Early Rye, to be cut for fodder, is flowering, 3-4 ft. high.

Ditches are filled with new rank growth of Carices (*C. riparia*, *C. paludosa*) now flowering out, with foliage of *Glyceria aquatica* and *Phragmites* concealing all old stems of the past season. *Hottonia* flowers freely, and the first larger Batrachian *Ranunculus* (*R. circinatus*) may show conspicuous patches. With the larger Carices, the river-bank is fringed with foliage of *Sparganium* and *Acorus* (3 ft.), *Scirpus lacustris* (5 ft.): *Nuphar* leaves rise to the surface; *Potamogeton natans*, *Callitriche* and *Lemna* mantle quiet streams.

In gardens also the spring rush is over: bulbous plants (Tulips) give place to *Iris*, Paeonies, Lupins; and the first roses express the flora of early summer. The blank occasioned by the loss of the early spring flowers is soon made good by putting out 'Bedding plants', once the nights are free from frost, and similar plants appear in window-boxes.¹

Animal life has kept pace with the vegetation. Pheasants are hatching, as also fish-spawn; the May-fly (due May 19) may be seen as strays a week earlier in hot spells, and is drifted in the river. Small Pearl-bordered Fritillaries flit in the woodland.

The range of climatic conditions in the last week of May is again typical of the whole month. Temperature may range from a 'heat-wave', with shade temperature over 85°, to some 30 degrees less, with cold NE. wind and a temperature below that of a mild Christmas;² yet the trees are in full leaf, and the abundant vegetation and flowers give the impression of full summer growth apparently unaffected. That is to say, spells of low temperature may slow down the great mass of photosynthetic vegetation, and delay the season for 2-3 weeks; but light is the essential factor, and the low temperature by day is less significant than the shortened dead period of the hours of darkness. The close of the Hawthorn period sees the end of the great majority of flowering trees and shrubs. A blank pause in garden and woodland succeeds the early spring rush of the first part of the month. Spring is over, but summer hardly come; leaving again a well-defined period before the maturation of the hay-crop, which marks the culmination of the pasture-grasses and their associated flora.

Flowering Plants (125) to May 25.³

(1) In Woodland—tree-forms:—

<i>Quercus pedunculata</i> ,	<i>Fagus sylvatica</i> ,	<i>Acer Pseudoplatanus</i> ,
<i>Ilex Aquifolium</i> ,	<i>Rhamnus catharticus</i> ,	<i>Viburnum Opulus</i> ,
<i>Euonymus europaeus</i> ,	<i>Acer campestre</i> ,	<i>Sambucus nigra</i> ,
<i>Crataegus monogyna</i> ,	<i>Cornus sanguinea</i> .	

¹ Scarlet *Pelargonium zonale*, yellow *Calceolaria*, white *Marguerites* (*Chrysanthemum frutescens*), and blue *Lobelia* are still popular.

² May 29, 1923, temp. 50°: June 1, temp. 55°.

³ Following the general plan of the April schedule, these headings are again subject to overlapping, owing to the artificiality of many of the formations. Woodland plants may be intrusive in pastures, swamp-forms in damp meadows; as plants of dry heath-land invade dry pastures as well as open clearings on gravel and sand. Roadsides and walls may give stray forms precociously flowering found later in pastures, as pastures may give stray forms flowering later in shaded woodland.

(2) Herbaceous Perennials of Woodland and Clearings :—

<i>Potentilla Tormentilla</i> ,	<i>Carex sylvatica</i> ,	<i>Rumex Acetosella</i> ,
<i>Lysimachia nemorum</i> ,	<i>Sanicula europaea</i> ,	<i>Veronica officinalis</i> ,
<i>Listera ovata</i> ,	<i>Sagina procumbens</i> ,	<i>Senecio sylvatica</i> ,
<i>Conopodium denudatum</i> ,	<i>Allium ursinum</i> ,	<i>Hypochaeris radicata</i> ,
<i>Orchis maculata</i> ,	<i>Luzula congesta</i> ,	<i>Lepigonum rubrum</i> ,
<i>Melica nutans</i> ,	<i>Aquilegia vulgaris</i> ,	<i>Scrophularia nodosa</i> ,
<i>Paris quadrifolia</i> ,	<i>Asperula odorata</i> ,	<i>Cardamine flexuosa</i> .

(3) Hedges and Roadside mixture :—

<i>Geranium molle</i> ,	<i>Bromus sterilis</i> ,	<i>Galium Aparine</i> ,
<i>Geranium pyrenaicum</i> ,	<i>Crepis taraxacifolia</i> ,	<i>Geum urbanum</i> ,
<i>Geranium dissectum</i> ,	<i>Vicia sepium</i> ,	<i>Crepis virens</i> ,
<i>Geranium lucidum</i> ,	<i>Chaerophyllum temulum</i> ,	<i>Pastinaca sativa</i> ,
<i>Geranium rotundifolium</i> ,	<i>Veronica arvensis</i> ,	<i>Chelidonium majus</i> ,
<i>Parietaria officinalis</i> ,	<i>Reseda lutea</i> ,	(<i>Symphytum orientale</i>),
<i>Potentilla Anserina</i> ,	<i>Poterium Sanguisorba</i> ,	<i>Rubus caesius</i> .

(4) Dry Heathy Pastures (sandy or calcareous) :—

<i>Helianthemum vulgare</i> ,	<i>Polygala vulgaris</i> ,	<i>Linum catharticum</i> ,
<i>Lotus corniculatus</i> ,	<i>Hieracium Pilosella</i> ,	<i>Plantago Coronopus</i> ,
(<i>Alchemilla vulgaris</i>),	<i>Ornithopus perpusillus</i> .	

(5) Hayfields and Damp Pasture :—

<i>Anthoxanthum odoratum</i> ,	<i>Trifolium repens</i> ,	(Flood Meadow)
<i>Alopecurus pratensis</i> ,	<i>Tragopogon pratense</i> ,	<i>Lychnis Flos-cuculi</i> ,
<i>Poa pratensis</i> ,	<i>Chrysanthemum Leucanthemum</i> ,	<i>Senecio aquaticus</i> ,
<i>Bromus mollis</i> ,		<i>Carex disticha</i> ,
<i>Vicia hirsuta</i> ,	<i>Rhinanthus Crista-galli</i> ,	<i>Carex panicea</i> ,
<i>Vicia angustifolia</i> ,	<i>Orchis Morio</i> ,	<i>Carex hirta</i> ,
<i>Rumex Acetosa</i> ,	<i>Geum rivale</i> ,	<i>Eleocharis palustris</i> ,
<i>Trifolium pratense</i> ,	<i>Pedicularis sylvatica</i> .	

(6) Swamp Woodland :—

<i>Ranunculus Flammula</i> ,	<i>Veronica Beccabunga</i> ,	<i>Carex vulpina</i> ,
<i>Viola palustris</i> ,	<i>Schoenus nigricans</i> ,	<i>Carex acuta</i> ,
<i>Valeriana dioica</i> ,	<i>Eriophorum polystachion</i> ,	<i>Carex paniculata</i> ,
		<i>Carex pendula</i> .

(7) Sub-aquatics of Ditch and River-bank :—

<i>Hottonia palustris</i> ,	<i>Nasturtium officinale</i> ,	<i>Nasturtium amphibium</i> ,
<i>Cardamine amara</i> ,	<i>Ranunculus sceleratus</i> ,	<i>Carex paludosa</i> .

(8) Aquatics of open water :—

<i>Hippuris vulgaris</i> ,	<i>Callitriche stagnalis</i> ,	<i>Ranunculus fluitans</i> .
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(9) Cultivated fields and Allotment areas :—

<i>Scandix Pecten-Veneris</i> ,	<i>Alopecurus agrestis</i> ,	<i>Lycopsis arvensis</i> ,
<i>Lithospermum arvense</i> ,	<i>Spergula arvensis</i> ,	<i>Thlaspi arvensis</i> ,
<i>Papaver Argemone</i> ,	<i>Sonchus oleracea</i> ,	<i>Anthemis arvensis</i> ,
<i>Papaver Rhoeas</i> ,	<i>Lepidium sativum</i> ,	<i>Matricaria Chamomilla</i> ,
<i>Trifolium incarnatum</i> ,	<i>Alchemilla arvensis</i> ,	<i>Anagallis arvensis</i> ,
<i>Fumaria officinalis</i> ,	<i>Cerastium arvense</i> ,	<i>Lychnis vespertina</i> ,
<i>Onobrychis sativa</i> ,	<i>Ranunculus arvensis</i> ,	(<i>Secale cereale</i>).

(10) On wall-tops :—

(<i>Centranthus ruber</i>),	<i>Scleropoa rigida</i> ,	(<i>Dianthus caesius</i>).
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(11) Flowering trees and shrubs in general garden-cultivation :—

<i>Aesculus Hippocastanum</i> ,	<i>Pyrus Aucuparia</i> ,	<i>Weigelia rosea</i> ,
<i>Pavia rubicunda</i> ,	<i>Juglans regia</i> ,	<i>Tamarix gallica</i> ,
<i>Pavia flava</i> ,	<i>Wistaria sinensis</i> ,	<i>Ceanothus azureus</i> ,

Platanus acerifolia,
Lycium barbarum,

Laburnum vulgare,
Prunus Padus,

Choisya ternata,
Clematis montana.

(12) Plants of the April list now conspicuously culminating:—

Ajuga reptans,

Carex riparia,

Ranunculus acris,

Fragraria vesca,

Lychnis dioica,

Ranunculus bulbosus,

Stellaria Holostea,

Anthriscus sylvestris,

Plantago lanceolata,

Lamium Galeobdolon,

Veronica Chamaedrys,

Bellis perennis.

V. EARLY SUMMER AND THE HAY CROP

During the month of June the optimum conditions of the end of May normally continue unabated. The hours of possible sunlight increase slightly from $16\frac{1}{4}$ at the beginning of the month to the longest day (June 21, $16^{\circ} 34'$) and the fall is but slight at the end ($16\frac{1}{2}$); though the record of hours of bright sunshine is slightly less than the May average (working out at 192.6),¹ and dull cloudy periods account for 60% of the total time of daylight. Exceptional dry and bright seasons give a record of 248 hours sun (1914), and as much as 15.3 hours in one day (June 20, 1915). The temperature is still prevalingly high. The average highest shade temperature by day is 78.7° ; a range above 80° is frequent, with the highest record at 88.6° (June 17, 1917); while the sun temperature may be as much as 148.6° (June 29, 1914). On the other hand the mean night-temperature may drop to 41.3° , with the possibility of frost not wholly eliminated (26.8° June 15, 1892; 31.1° June 14, 1924).²

With such increasing heat the water-problem may begin to be insistent; and though the rainfall averages 2.374 in. (mean of 70 years), the extremes range from less than half an inch to nearly 6 (0.567 in 1913; only 0.34 in the continued drought of 1921, and 0.42 in 1923; on the other hand, 5.818 in 1903, a flood-year).

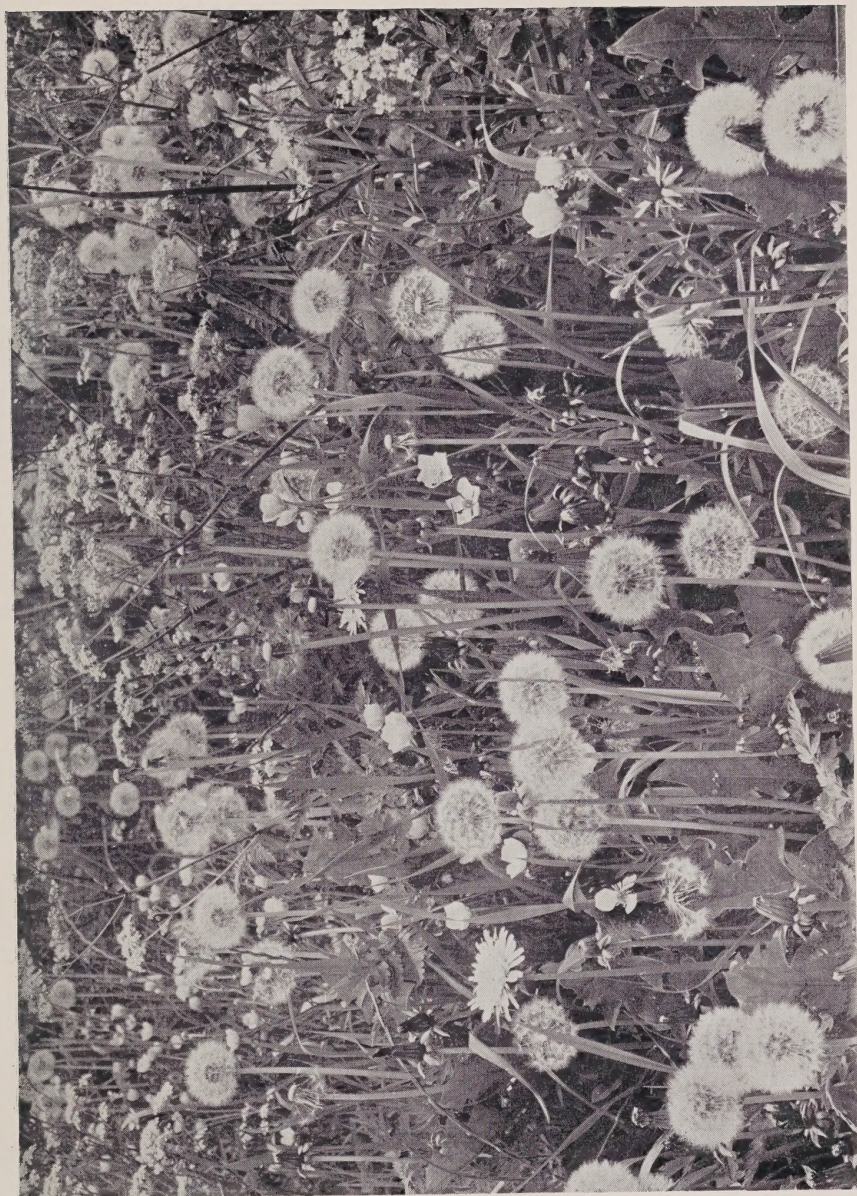
June 1923 was of special interest as affording an example of conspicuous failure in all climatic factors of temperature, light, and rainfall. The day temperature was consistently low, and nearer 50° than 60° ; the first warm day was the 23rd; winter clothing and fires being general until after the longest day.³ The hours of bright sunshine were registered as only 126 out of a possible 496 (only less in 1909), or only 25% of total daylight, and the month was the driest known with the exception of 1921.

Even such extreme failure in the climatic factors has little effect on the general plant-progression of the month. Long hours of diffused daylight and a low temperature are more generally useful than a scorching sun. Water-supply is again the critical factor; but deep-rooted plants, perennating from the preceding autumn, so far show little damage; though spring-sown crops and

¹ Mean of 40 years, Radcliffe Observatory Reports.

² loc. cit., a marked white-frost outside the town-area. Radcliffe records taken in the sheltered grass-land of the Observatory afford a good mean range, but the extremes are wider outside the city. Sun temperatures are higher in stony tracts, as frost-effects are more pronounced in exposed areas (Headington, Bagley Wood). Frosts in mid-June are exceptional, but the possibility is never eliminated, even on the longest day; June 21, 1888, is given in the Radcliffe Records as reducing on the grass to 32.2° (suggested as the result of frozen hail). Other observers record a frost overnight which killed the early Potatoes, and blackened the Runner Beans when 3 ft. high: such night frosts are associated with cold N. and NE. winds.

³ Frosts were general in the first week (29.5° recorded in the town, June 3); at Headington the ground was described as being white as snow at 6 a.m. (summer time), and ice in the grass crunching under one's boots. Much Bracken was killed in the open. With a temperature comparable with that of a mild Christmas, associated with the full vegetative growth of summer, it is evident that the significant factor is the length of the day, and the ratio of the hours of sunlight to those of darkness, now the converse of the mid-winter period.



II. Pasture Weeds ; Dandelion, *Ranunculus bulbosus*, *Anthriscus* ; Cowley ; May 26, 1922.



12. Meadow Hay and Watercourse in the Alluvium ; *Sparganium*, *Nuphar*,
Oenanthe, *Ranunculus circinatus*, *Lemna* ; S. Hinksey, June 27, 1923.

garden-produce may be destroyed. Drought, again, helps to retard the summer-annuals as weeds, and the progression of the month may be delayed for 1-2 weeks. As a matter of fact, the general floral display was unaffected, as blossoms were not wilted by heat, and maintained their colour and functional mechanism for a longer period. The Hay-crop was distinctly good, and the growth of the flood-meadows, as also the harvest of winter-sown wheat and oats, quite normal.

June 1924, with markedly heavy rain-fall in the first half of the month, following heavy rains in late May, gave a June flood,¹ the most pronounced since 1903, when the first crop of hay was left to blacken on the alluvial meadows after cutting. Water rose in the grass of the Flood-meadows, in spite of improved management of the stream, and much hay was damaged by silt. On the other hand a June flood, by filling the river-bed and ditches, considerably retards aquatic vegetation; the banks are scoured by flood-water, and much growing bank-vegetation is drowned out.

All plant-growth continues actively as such conditions approach the optimum, so far as is possible, for plant-life in this part of the world; the most remarkable feature being the great length of the working day, with general possibilities of a high temperature and an adequate rain-fall. Hence active photosynthetic work is the special characteristic of the month; the vogue of plants flowering with an early start at the expense of material stored from a previous season is largely over, and the new series of plants are reproducing at the expense of the work done in the current season. These include a large number of annuals which germinated in the autumn or mild months of winter and early spring.

As typical of this June period may be taken:—

- (1) The Elder (*Sambucus nigra*), abundant in woodland and hedgerows, with inflorescences begun in the perennating buds, but steadily increasing with the photosynthetic leaves, to bloom early in June; the plant as a human associate in artificial hedges bearing much the same relation to June as does the Hawthorn to May, flowering on throughout the month to the first weeks of July.
 - (2) The annual Poppy (*Papaver Rhoeas*) of the cornfields, an alien of old time, sown with the autumn tillage of the soil for winter wheat, and growing rapidly to produce its flowers in early June before and with the flowering of the Wheat-crop.
 - (3) The Common Sting Nettle (*Urtica dioica*), also a human associate, ubiquitous in all derelict ground, and intrusive in woodland, with perennating rhizome sending up new shoots (1-4 ft.) at the expense largely of stored material, and elaborating the lateral paired inflorescence-systems in June.
- On the other hand, Roses, often regarded as essentially the typical flower of June, in garden-cultivation or wild (*Rosa canina*, *R. arvensis*), as also Brambles (*Rubus*), produce flower-shoots from wood of the previous season, largely at the expense of food-material stored in 'well-ripened' wood, as an extension of the flowering-spur scheme, clearly secondary, while they are sending up new leafy sucker-shoots (3 ft.).

The increasing heat brings on all plant-forms rapidly; herbaceous field-plants and garden-forms grow and run up to flower in great profusion; the month adds over 170 species to the floral record. This season of early summer may be regarded as dating from the flowering out of the Hawthorn (with associated Horse-chestnuts, Lilac, and Laburnum), the Keck of the hedgerows, and the main crop of Buttercups in the pastures, or again from the flowering of *Pinus sylvestris*, to the initiation of a dry summer-period towards the close of the month. The beginning of this period is at once removed from the idea of Spring; leaf-fall begins to be pronounced in the

¹ June 5, following a rain-fall in May of 4·154 in.: the June fall 3·443 in., chiefly in the first part of the month.

case of evergreens (Holly, Ivy, Cherry, Laurel, and *Quercus Ilex*), as the new foliage replaces the old. In dry seasons the shedding of the first shaded new leaves of the Willows may be pronounced, as is also the general dropping of old cones from *Pinus*: the first flowers of the year are conspicuously seeding out; *Draba* is disappearing, though it may persist on gravel-paths to mid-June; the main crops of early Dandelions and *Senecio vulgaris* have seeded out; the early Willows (*Salix caprea*, *S. cinerea*, *S. fragilis*) are seeding out, and fruits are ripened or shed, immature and sterile, in great quantity from Wych Elm and Huntingdon Elms.

Annual shoots attain the limit of their normal extension; the foliage is adult and functional on all indigenous trees. The leaves take on a duller green, and canopy is developed to its maximum capacity, beyond which regulation can be only effected by shedding the older members as the water-supply diminishes. Hence the recognition of the period as that of 'Leafy June'; all trees being furnished with new foliage, and so far normally none shed.¹

In the woodland flowering forms diminish in number and effective display, though underwood shrubs include:—

Euonymus europaeus,
Sambucus nigra,

Rosa canina,
Cornus sanguinea,

Lonicera Periclymenum,
Viburnum Opulus.

The majority of trees show fruiting stages.² Green fruits are growing rapidly on Apples, Pears, Cherries, Currants, and *Juglans*. Beech-nuts are nearly full size, Alder cones and Birch catkins are well-developed in fruit; even *Tilia* shows the wing-bracteole precociously formed before flowering, and samaroid fruits are conspicuous on Ash, *Carpinus*, and *Acer* (sp.). The woodland base is filling up with Bracken (2-4 ft.) and Brambles (*R. caesius*) flowering a month in advance of other forms (*R. fruticosus*): new shoots of *Teucrium*, *Circaea*, and *Epilobium angustifolium* add to the density of the cover, and fruiting spikes of *Scilla* are largely lost to sight. *Sanicula* and *Ajuga* are still dominant, with many casual intrusives of open clearings and forest-plots. A marked tendency of forms in shaded woodland to lag behind may be noted; e.g. *Anthoxanthum odoratum*, as an early grass in May pastures, is essentially a woodland form of June with a distinct shade-aspect. The last Celandines, as also *Cardamine pratensis*, may be seen in the first week of the month, and even a residual *Scilla* in the open (June 5), a fortnight after the fading of the main crop; these expressing the range of residual strays. By the first week of June the Hawthorn blossom should be fading out;³ Celandines have normally shed their fruits, as also have the Wood Anemones, though much of their foliage still remains. Primroses and Violas (*V. Riviniana*, *V. hirta*) still grow strongly with green capsules, the leaves actively functional until the onset of summer drought. The cover of the Bracken is still scanty in the open, and liable to destruction by late frosts, though getting denser under the protection of low-crowned Oaks. In hot seasons the foliage of the latter may be completely devastated by the caterpillars of the Tortrix moth,

¹ In backward seasons (1923) Ash may be only showing feeble leaf by June 1, and the foliage barely renewed by the middle of the month. Cultivated trees (Fig, Vine, Walnut, *Populus serotina*, *Ailanthus glandulosa*, *Ginkgo*, *Gymnocladus*) even more delayed, and some, *Ailanthus* and *Gymnocladus*, only become green and covered in the first week of July.

² Following excessive fruit-production in 1922, there was no fruit on Beech, *Carpinus*, Sloe, little on Hawthorn, and only exceptionally on Sycamore, Oak, and Hazel in 1923. 1924 showed a conspicuous recovery in the case of Sycamore, Holly, and Walnut, leading to abundant crops of fruit.

³ In late wet season (1924) the last persisted to June 14; but was conspicuously faded pink June 7.

letting in more light on the woodland base.¹ Characteristic herbaceous forms of the underwood include :—

<i>Lysimachia nemorum</i> ,	<i>Conopodium denudatum</i> ,	<i>Carex sylvatica</i> ,
<i>Euphorbia amygdaloides</i> ,	<i>Melica nutans</i> ,	<i>Listera ovata</i> ,
<i>Geum urbanum</i> ,	<i>Epilobium montanum</i> ,	<i>Veronica Chamaedrys</i> .

In the clearings and forest-plots *Fragraria vesca* is remarkably abundant, with the first fruits already ripening, as also stretches of—

<i>Potentilla Tormentilla</i> ,	<i>Veronica officinalis</i> ,	<i>Rumex Acetosella</i> ,
<i>Aira praecox</i> ,	<i>Galium saxatile</i> ,	<i>Hieracium Pilosella</i> .

Rough grasses attain dominance :—

<i>Festuca duriuscula</i> ,	<i>Festuca bromoides</i> ,	<i>Holcus lanatus</i> ,
<i>Dactylis glomerata</i> ,	<i>Bromus mollis</i> ,	<i>Bromus sterilis</i> .

The most conspicuous herbaceous types are the Burdock (*Arctium*)—the basal foliage-leaves of which may be 2 ft. long and 1½ ft. broad—and the spinous rosettes and new growths of *Carduus palustris*. A few residual Orchids (*O. maculata*, *Platanthera chlorantha*), as also any Columbines (*Aquilegia*), are commonly gathered on sight.

In hedgerows the white corymbs of the Elder replace the Hawthorn to a certain extent; with *Viburnum Opulus* near ditches, *Rosa canina*, and the white blossoms of *Rubus caesius*. Abundant leafy trails of climbing plants mingle with the shrub-flora (*Bryonia*, *Tamus*, and *Solanum Dulcamara*). The hedge-bottom tends to become dry, filling up with *Galium Aparine* and coarse grasses (*Bromus sterilis*, *B. mollis*, *Dactylis*, *Festuca* (sp.), *Arrhenatherum*, and *Poa trivialis*): by calcareous roadsides *Bromus erectus* is locally abundant.² Minor plants include :—

<i>Veronica Chamaedrys</i> ,	<i>Lotus corniculatus</i> ,	<i>Lathyrus pratensis</i> ,
<i>Trifolium repens</i> ,	<i>Potentilla Anserina</i> ,	<i>Convolvulus arvensis</i> ,
<i>Galium Mollugo</i> ,	<i>Stachys sylvatica</i> ,	<i>Vicia sepium</i> ;

with intrusive weeds of waste places and human association :—

<i>Plantago major</i> ,	<i>Aethusa Cynapium</i> ,	<i>Malva sylvestris</i> ,
<i>Urtica dioica</i> ,	<i>Aegopodium Podagraria</i> ,	<i>Malva rotundifolia</i> ,
<i>Conium maculatum</i> ,	<i>Chenopodium Bonus-Henricus</i> ,	<i>Sonchus oleraceus</i> ;

and towards the end of the month, the first representatives of a more xerophytic summer-flora :—

<i>Ballota foetida</i> ,	<i>Daucus Carota</i> ,	<i>Carduus crispus</i> .
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The Keck is fruiting out, though replaced to some extent by the very similar *Chaerophyllum temulum*, and near habitations locally by *Aegopodium*. *Stellaria Holostea* and *Lychnis dioica* give place to weedy leafy growths of Nettles, Docks, and Galiums, with the first Thistles. Hedgerows as wholly artificial stations reflect the general nature of the plant-life of their surroundings, and with the advance of the season, a marked differentiation is noted between the hedgerow through woodland, a hedge-bank on dry calcareous soil, and the hedges within the zone of human occupation. A rough grading between woodland forms (humicolous), or more calcicolous plants, and human associates flourishing in fouled ground and on areas frequently cleared, marks the general distinction between 'weeds' and 'wild flowers'. The casual weeds of direct human association may again be distinguished from the casual weeds of agricultural crops, as these follow

¹ In cool backward June (1923) the Tortrix pest was much reduced, and the oaks attained unwonted dense canopy: the same effect followed the extreme rainy period of May and early June (1924).

² Recorded by J. Bobart (1690) for Cumnor Hill roadside.

the periodicity of the fields, and their human association is less obvious, as their appearance is more beautiful.

Arable land presents a dense growth of corn and associated 'weeds'. The Wheat is now 3 ft. high, as a dense leafy crop with the ear beginning to show. Winter-sown Beans are 3 ft. high, and in full bloom. Weeds mingle with the crop, and abound along field-tracks, on rick-sites, and waste-heaps, as Charlock (*Sinapis arvensis*), Radish, Poppies (*Papaver Argemone*, *P. Rhoeas*, *P. dubium*), and the casuals of cultivation; the commoner being:—

<i>Sonchus asper</i> ,	<i>Lychnis Githago</i> ,	<i>Spergula arvensis</i> ,
<i>Scandix Pecten-Veneris</i> ,	<i>Lithospermum arvense</i> ,	<i>Lychnis vespertina</i> ,
<i>Knautia arvensis</i> ,	<i>Specularia hybrida</i> ,	<i>Anthemis arvensis</i> ,
<i>Silene inflata</i> ,	<i>Lycopsis arvensis</i> ,	<i>Melilotus officinalis</i> ,
<i>Convolvulus arvensis</i> ,	<i>Bartsia Odontites</i> ,	<i>Chrysanthemum segetum</i> ,
<i>Bromus secalinus</i> ,	<i>Avena fatua</i> ,	<i>Lolium italicum</i> .

Waste ground gives large Umbellifers, *Heracleum Sphondylium* and *Pastinaca sativa* (3–6 ft.), Nettles, *Plantago* (sp.), and coarse grasses; but, so far, no Chenopods (*C. album*); *Atriplex* and *Polygonum* (*P. aviculare*) are represented by abundant seedlings (3–6 in.). Thistles are still backward, though green shoots of *C. arvensis* are ubiquitous. The most omnipresent forms are Daisies, Dandelions, *Plantago*, *Senecio squalidus* and Common Groundsel, with *Poa annua* and *Hordeum murinum* as the pioneers in all open situations on denuded soil. Children and adults, ranging the countryside, collect bunches of Ox-eye daisies (*Chrysanthemum Leucanthemum*), *Lychnis Flos-cuculi*, Sainfoin, *Briza media* ('Quakers'), Yellow Flag (*Iris Pseudacorus*), with Buttercups, fruiting Sorrel (*Rumex Acetosa*), and Guelder-rose (*Viburnum Opulus*).¹

Hay Harvest. The main interest of the period centres in the growth of the pasture-grasses utilized for hay, as the first crop grown for a harvest in the district, affording material indispensable for feeding cattle throughout the winter, and of primary importance for all stock-raising. The hay-harvest which represents the collection of drying grass-plants with maximum retained content of food-reserves, including seeds still unshed, may be thus taken as representing the culmination of the new season's growth.

With the grasses may be associated the similar completion of the annual working period of a large number of plants growing with the grasses as part of the same type of prairie-formation, and similarly expressive of an early state of maturation in order to withstand in the seed-stage, or by other modes of perennation, the advancing desiccation of a dry summer season.

The constitution of the flora forming such pasture-associations naturally varies somewhat according to the time the fields are cut, the nature of the soil, and the amount of available water-content; the last being the most significant factor. References apply more particularly to permanent pastures held for hay with little special preparation or culture. Fields of sown grass and fodder-plants follow the same biological progression, and include much the same weed-flora; but their management comes under the practice of agriculture and the general rotation of farm-crops. Sown fodder-plants and 'grass-seeds', whether cut green for fodder or dried for hay, include:—

Lucerne (<i>Medicago</i>),	Sainfoin (<i>Onobrychis</i>),	Rye (<i>Secale</i>),
<i>Vicia sativa</i> ,	<i>Trifolium incarnatum</i> ,	<i>Trifolium pratense</i> ,
<i>Lolium perenne</i> ,	<i>Lolium italicum</i> ;	

¹ The eagerness with which children especially pick and pull at any decorative flowers of field crops, suggests the importance of this human factor in the past as tending to eliminate the chance of survival of any beautiful flowers as immediate human associates in an unprotected condition, and thus accounting for the particularly insignificant claims of such common plants to any aesthetic value; save in the case of a few too flimsy to stand when gathered (*Dandelion*, *Malva sylvestris*).

and in lesser degree, or in mixture (Leguminosae):—

<i>Trifolium minus</i> ,	<i>Trifolium repens</i> ,	<i>Trifolium hybridum</i> ,
<i>Medicago lupulina</i> ,	<i>Melilotus officinalis</i> ,	<i>Anthyllis Vulneraria</i> ,
<i>Lathyrus pratensis</i> ,	<i>Lotus corniculatus</i> ,	<i>Vicia angustifolia</i> ,
<i>Vicia hirsuta</i> ,	<i>Vicia Cracca</i> .	

Locally it is possible to distinguish between different types of Hay-field, as:—

(1) Water-meadows, more or less liable to winter-flood, on the alluvium of river-washed clay silt.

(2) More ordinary pastures on clay-tracts or Terrace Gravel, possibly at some time utilized as arable fields.

(3) Pastures on calcareous (Corallian) soil.

(4) Sandy hill-pastures only occasionally cropped.

(5) Grass leys of the agriculturalist.

The general flora of these comprises over 30 species of grasses, of very unequal value as food-plants, and maturing at different times; together with over 50 associated herbaceous forms, hence distinguished as more ordinary 'flowering plants'; all again presenting differences in degree of distribution and relative abundance in fields of different category.

Coarser grasses, sub-aquatic forms, mingled in swampy tracts with Carices, *Juncus*, and Equiseta, as also similar reed-herbage of river-banks useless for fodder, may be cut for bedding, with comparable effects on the herbaceous flora, thus maintained in an artificial condition by eliminating all attempts at colonization by woody forms. Pastures of poorer grade, set apart for summer-grazing, are the more open to intrusion by plants of waste ground, and readily deteriorate to incipient Thorn-scrubs if dry, or to Juncetum in damp levels.

The grasses common to all permanent pastures include:—

<i>Anthoxanthum odoratum</i> ,	<i>Alopecurus pratensis</i> ,	<i>Poa pratensis</i> ,
<i>Bromus mollis</i> ,	<i>Lolium perenne</i> ,	<i>Dactylis glomerata</i> ,
<i>Arrhenatherum avenaceum</i> ,	<i>Festuca pratensis</i> ,	<i>Holcus lanatus</i> ,
<i>Cynosurus cristatus</i> ,	(<i>Phleum pratense</i>),	(<i>Agrostis vulgaris</i>).

Of these *Holcus lanatus* and *Bromus mollis* are practically useless weeds; *Dactylis* and *Arrhenatherum* are conspicuous larger forms, rising 4-5 ft. in the flowering stage. *Phleum pratense* and *Agrostis vulgaris* do not normally flower until after the hay is cut (July), and *Anthoxanthum* is usually withered and its seeds shed before that time.

Alluvial fields and low-lying tracts on Oxford Clay add:—

<i>Poa trivialis</i> ,	<i>Bromus commutatus</i> ,	<i>Festuca elatior</i> ,
<i>Festuca loliacea</i> ,	<i>Festuca duriuscula</i> ,	<i>Bromus racemosus</i> ,
<i>Aira caespitosa</i> ,	<i>Hordeum pratense</i> ,	<i>Trisetum flavescens</i> ;

Permanently damp levels:—

<i>Glyceria fluitans</i> ,	<i>Alopecurus geniculatus</i> ,	<i>Digraphis arundinacea</i> ;
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Dry sandy pastures (Greensand, Shotover Sand, Calcareous Grit):—

<i>Bromus erectus</i> ,	<i>Koeleria cristata</i> ,	<i>Aira caryophylla</i> ;
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Corallian (Coral Rag):—

<i>Avena pratensis</i> ,	<i>Festuca ovina</i> .
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Poa annua, *Bromus sterilis*, and *Hordeum murinum* appear as intrusives from wayside waste; *Glyceria aquatica* and *Phragmites communis* from river and ditch. *Briza media*, at an optimum in neutral wet swamp, also grows on thin clay soils and dry calcareous tracts.

The most characteristic hay-fields locally are the broad level alluvial tracts of Oxy Mead, Pixey Mead, Yarnton Mead; Marston and Cowley Fields on

Oxford Clay or Alluvium. Osney Fields and Iffley Fields on Alluvium show depauperation in variety of forms nearer the urban area, approximating the first section (12-20); on the other hand, conspicuous lack of some of these characteristic grasses commonly indicates an artificial pasture—'grass-seeds' of the agriculturalist, with a few predominant forms, or casual cases of cultivated *Lolium italicum* and *Festuca ovina*, *vivipara*.

Pastures on Corallian and sandy soils or Terrace Gravels are commonly derivative from land once arable, and these afford less interest; but the great alluvial tracts have a special ecological value, in that they have been mown annually from time immemorial—at any rate for several centuries—with little grazing, and may still give one if not two crops a season without special attention. In such case the grass-association may be regarded as to a certain extent stabilized, but there is no very noticeable preponderance of the larger and coarser forms (*Dactylis*, *Arrhenatherum*, *Aira caespitosa*), or in fact of any one plant.

With the annual mowing of the greater area may be contrasted the equally permanent grazing pasture of Port Meadow, which covers an intermediate range of Alluvium, and has been grazed continuously and thoroughly for some 800 years by the horses and cattle of City Freemen. It is known to have been allowed to produce hay crops only twice in the years of the Civil War (1645), when two crops were taken in each season. Sample turves, collected from selected spots, and allowed to flower on, gave merely a depauperated list of common forms (some 30), with no special features, and without the predominance of any one species. In the southern portion, which is still more or less swampy in persistently rainy weather, the most conspicuous form is perhaps *Juncus lamprocarpus* (vegetative shoots).

Very similar generalizations apply to the herbaceous associates of the grass crop. The forms common to all such fields, often flowering in immense profusion, are (12):—

<i>Ranunculus acris</i> ,	<i>Trifolium pratense</i> ,	<i>Bellis perennis</i> ,
<i>Cerastium vulgatum</i> ,	<i>Trifolium minus</i> ,	<i>Plantago lanceolata</i> ,
<i>Rumex Acetosa</i> ,	<i>Trifolium repens</i> ,	<i>Chrysanthemum Leucanthemum</i> ,
<i>Hypochaeris radicata</i> ,	<i>Medicago lupulina</i> ,	
<i>Leontodon hispidum</i> .		

Of these the Leguminosae (4) are included in the agricultural conception of 'grass-seeds' and clover-leys; the others are merely weeds of no value. To these the fine alluvial tracts beyond the town (Oxey Mead) add a wide range of flowering forms, including sub-aquatics intrusive from ditches and the river-bank (cf. *Caltha* and *Cardamine pratensis* of early Spring), mingled with more distinctly xerophytic rosette-forms of grass-land, and many Carices of the valley swamps. Specially characteristic of these flood-meadows are:—

<i>Thalictrum flavum</i> ,	<i>Tragopogon pratense</i> ,	<i>Rumex crispus</i> ,
<i>Senecio aquaticus</i> ,	<i>Spiraea Ulmaria</i> ,	<i>Carex glauca</i> ,
<i>Lychnis Flos-cuculi</i> ,	<i>Rhinanthus Crista-galli</i> ,	<i>Carex disticha</i> ,
<i>Sanguisorba officinalis</i> ,	<i>Silaus pratensis</i> ,	<i>Carex panicea</i> ,
<i>Myosotis palustris</i> ,	<i>Prunella vulgaris</i> ,	<i>Carex riparia</i> ,
<i>Nasturtium officinale</i> ,	<i>Oenanthe peucedanifolia</i> ,	<i>Carex vulpina</i> ,
<i>Stellaria glauca</i> ,	<i>Centaurea nigra</i> ,	<i>Eleocharis palustris</i> ,

with a general deficiency in Docks, Thistles, and *Heracleum*, unless in the vicinity of rick-sites raised above the flood-level.

The floral display of these meadows in early June is often very beautiful; and if they are not cut until late, the list is further extended by the forms of later summer, as more typically the plants of the aftermath.

Fields on Oxford Clay and Kimeridge Clay give a poorer selection;

to the general forms being added only weeds of grass-land, mainly as intrusives of human association and roadside waste :—

<i>Ranunculus repens</i> ,	<i>Centaurea nigra</i> ,	<i>Carduus arvensis</i> ,
<i>Anthriscus sylvestris</i> ,	<i>Plantago media</i> ,	<i>Carduus lanceolatus</i> ,
<i>Rhinanthus Crista-galli</i> ,	<i>Rumex crispus</i> ,	

with obvious weeds of cultivation—along footpaths :—

<i>Plantago major</i> ,	<i>Capsella Bursa-pastoris</i> ,	<i>Senebiera Coronopus</i> .
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Fields on Corallian outcrops, with full drainage, may include intrusive weeds of arable land, and add to the general forms :—

<i>Crepis taraxacifolia</i> ,	<i>Veronica Chamaedrys</i> ,	<i>Vicia angustifolia</i> ,
<i>Lotus corniculatus</i> ,	<i>Crepis virens</i> ,	<i>Vicia hirsuta</i> ,
<i>Lathyrus pratensis</i> ,	<i>Achillea Millefolium</i> ,	<i>Anthyllis Vulneraria</i> ,
<i>Lychnis vespertina</i> .		

Sandy tracts (Calcareous Grit, Shotover Sands) grading into pastures only occasionally cut for a crop, and subject to rough grazing, give :—

<i>Hieracium Pilosella</i> ,	<i>Conopodium denudatum</i> ,	<i>Rumex Acetosella</i> ,
<i>Senecio Jacobaea</i> ,	<i>Galium verum</i> .	

These lists do not include the casuals of roadsides, footpaths, and the ditch-side or river-bank, where these abut on the mown area. Where cut regularly, later-flowering Thistles (July) and larger plants as Docks (*Rumex obtusifolius*, *R. crispus*, *R. conglomeratus*), *Heracleum*, and *Spiraea Ulmaria*, are kept down; though where the crop is neglected these flourish and may become conspicuous later in the season (July). In all cases as the grass-crop grows denser, and dominant in its flowering stages, other flowering plants become less obvious. Conversely, the floral display is greater before the grass is full grown, or again whenever conditions are unfavourable for its active growth—whether too cold, or too dry. As particularly abundant in special stations, colouring wide tracts of meadowland, may be mentioned:—the Buttercups of May, *Rhinanthus Crista-galli* (yellow), *Rumex Acetosa* (dull red), *Anthriscus sylvestris* (white), *Oenanthe peucedanifolia* (white), *Chrysanthemum Leucanthemum* (white), in June; with *Sanguisorba officinalis* (black tint), *Spiraea Ulmaria* (white), *Galium verum* (yellow), in July.

Similar alluvial fields nearer the town-area show progressive deterioration in the number of species, as also in the beauty of the association of flowering plants; this being apparently the result of more intensive grazing.

The closely grazed permanent pasture of Port Meadow shows more definite differentiation from the similar alluvium of Oxey Mead and Iffley Fields. The northern portion (Wolvercote end), corresponding to the old race-course portion, is now rarely flooded, and the closely grazed turf exposed to desiccation shows intrusives of dry pasture, with abundance of thistles (*Carduus lanceolatus*, *C. palustris*), with minor forms as *Thrinicia hirta*, *Potentilla reptans*, *Lotus corniculatus*, and *Carduus acaulis*.

The southern end, between the Round Hill and the river, more within the influence of Head Water at Medley Weir, and commonly the first to be flooded, gives a close damp turf, squashy in wet weather, in which small intrusives from the ditches and river-bank appear, as dwarfed sub-aquatics distinct from the normal flora of a mown hay-crop :—

<i>Myosotis palustris</i> ,	<i>Apium nodiflorum</i> ,	<i>Ranunculus Flammula</i> ,
<i>Galium palustre</i> ,	<i>Veronica Anagallis</i> ,	<i>Veronica Beccabunga</i> ,
<i>Eleocharis palustris</i> ,	<i>Triglochin palustre</i> ,	<i>Oenanthe fistulosa</i> ,
<i>Hippuris vulgaris</i> ,	<i>Juncus lamprocarpus</i> .	

It is also possible to draw a distinction between alluvial fields flooded directly from the river, by more or less running water, which drains away

comparatively soon, and fields flooded with standing water from ditches and backwaters of indefinite duration. The latter tend to fill up with:—

Spiraea Ulmaria, *Phalaris arundinacea*, leafy shoots of *Glyceria aquatica*, and *Phragmites*, as also *Juncus glaucus*, *Juncus lamprocarpus*, with *Rumex crispus* characteristically at the flood-margin (cf. Meadow Lane, Iffley; Fields near Dolly's Hut, Hayfield Road).

The better quality of hay, from the agricultural standpoint, is now obtained from grass-leys on better ground; i.e. from rotation fields once arable, cultivated, and well-drained, on Corallian or Terrace-gravel; all repaying manuring in the spring, especially where the material is obtainable from cow-sheds.¹ Hay from the alluvial flood-meadows is often thin and of poor quality, as the winter-flood is more controlled. The amount of silt deposited may be considerable, as shown by the accumulation of mud among bottom grass in a June flood. Such deposition will diminish with improved management of the river, as the flood-water is rapidly run off (cf. the new Lock at Iffley); and the grass-crop also tends to deteriorate where the river is constantly held up at Head Water above the locks (as high as possible without permanent flooding), cf. Pixey Mead and Port Meadow. The value of the flood-meadows formerly consisted in the possibility of getting a second crop in September, when the rainfall is satisfactory; but this has been latterly neglected. Sandy upland fields, dried out and bleached after the June crop, may not recover in the succeeding season. The density of the crop, and its feeding value, is increased by the massed shoots of Clovers and the other Leguminosae already mentioned, and this thick bottom-growth may include vegetative shoots of a large number of plants which should come into bloom later in the year, both on the exposed dry turf, or on damp alluvium, flowering freely as a later crop kept in miniature dimensions by the first mowing (cf. *Aftermath*). In damp levels the crop is deteriorated in quality by the presence and even predominance of many *Juncus* and *Carex*-forms of very similar grass-habit (*J. lamprocarpus*, *J. conglomeratus*, *J. glaucus*; *Carex riparia*, *C. paludosa*, *C. vulpina*, *C. disticha*, *C. panicea*, *C. glauca*). Small paddocks may become overrun with *Anthriscus sylvestris* (Keck), or this may be intrusive for 50–100 yards from the hedges, giving a waving mass of tossing white umbels. Other weeds of human association may be conspicuous near habitations; as *Polygonum amphibium*, *Agropyrum repens*.

The sequence of flowering forms is usually sufficiently marked; but the average date for first-flowering and culmination varies within a week or two according to climatic factors in succeeding years. The grasses of May (*Anthoxanthum*, *Alopecurus pratensis*, *Bromus mollis*, *Poa pratensis*) extend into early June in diminishing quantity, and the first week of June sees the advance of *Lolium perenne*, *Festuca duriuscula*, and *Dactylis glomerata*.

¹ Hay is now cut by horse-reaper which does the work done formerly by 10 men with scythe, and distributed by a horse-tedder which does the work of 15 men. Grass loses about three-quarters of its weight in drying, and the dried pale-green material is collected into ricks; these being more usually built in the fields where more convenient for storage and transport. The shape of the rick is rectangular with a pyramidal apex; the dimensions following old custom, in which the height of the eaves is given by the distance to which the hay can be pitchforked from a cart (10–12 ft.); but by the use of an elevator hay can be thrown up to 30 ft. Damp hay gives a characteristic odour as fermentation sets in, the critical temperature for which is 170° F. Small ricks are preferable, as being less liable to overheating. Large ricks contain 30–40 tons of hay, and may be 36 ft. long, 30 wide, and 25 high. They are thatched with straw (line and willow-pins), not always too neatly. The general yield averages 2 tons per acre; thin crops reducing to 1 ton, while best cultivated grass, manured and bush-harrowed, will give 3 tons. But such grass is now little cultivated, as the demand for horses falls off; and hay is taken as a product of nature to be 'saved' rather than 'harvested'. The price of the finished material, cut into trusses of $\frac{1}{2}$ cwt., averages £5 per ton; though reaching as high as £8 in dry spring when no other fodder is obtainable within the town-area, or as little as £2 offered for hay in the rick (1924).

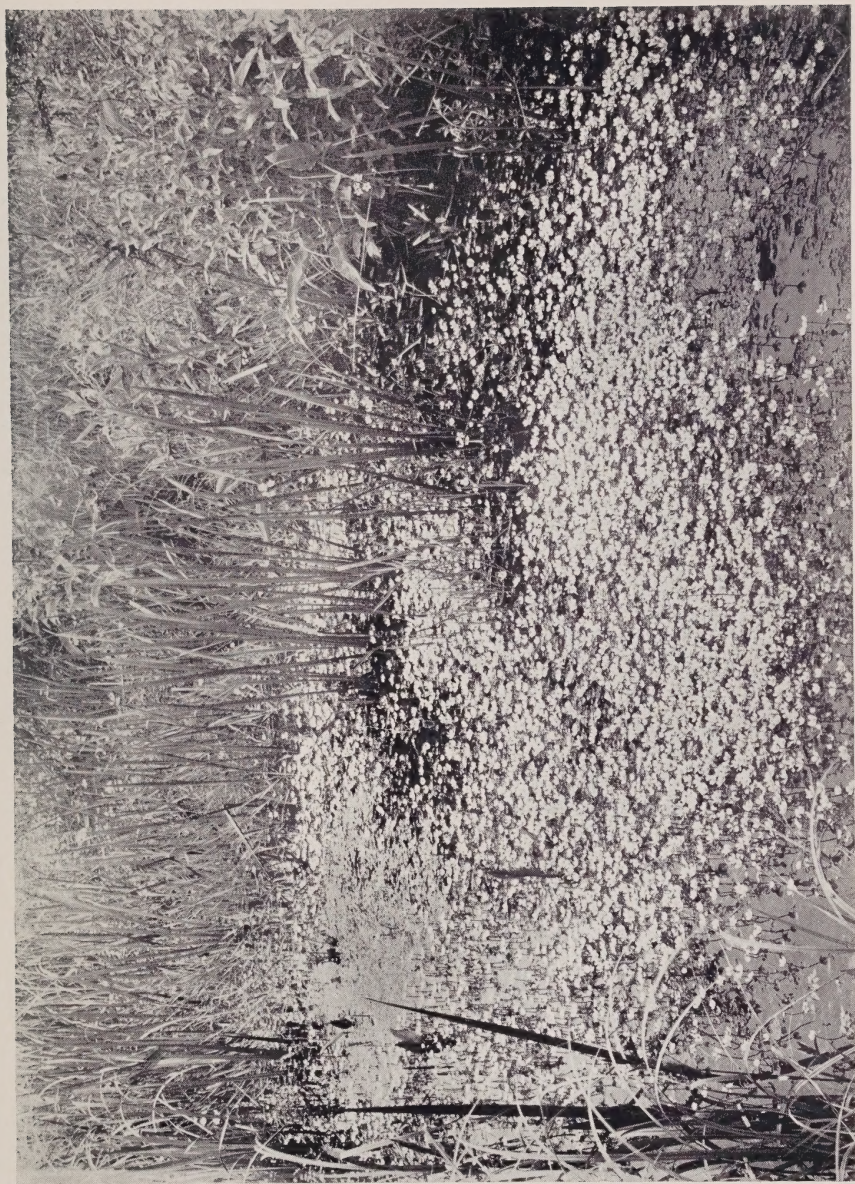


Fig. 13. Ditch in Iffley Alluvium; *Ranunculus circinatus*; June 9, 1922.



14. *Ranunculus circinatus* ; Iffley, June 7, 1922.

Calcareous pastures produce a crop of *Avena pratensis*.¹ The second week adds the grasses of the main crop: *Festuca pratensis* and *F. loliacea* in damper levels; *Poa trivialis* spreads from damp ditches, *Holcus lanatus* is ubiquitous as a weed. Swampy tracts abound in the slender arching panicles of *Glyceria fluitans*, and *G. plicata*. These are followed by *Brisa media*, *Bromus racemosus*, *B. commutatus*, *Cynosurus cristatus*, and *Arrhenatherum avenaceum*. In the third week of June the first grasses are already seeding out, and may be wholly bleached (*Anthoxanthum*, *Bromus mollis*); and, as in hot weather seed is matured within a fortnight of flowering, the crop may with advantage be taken as soon as the flowering stages of the dominant forms are over. The closing up of the tall waving panicles of *Arrhenatherum* (5 ft.) marks the limit of the period. Where the crop is not cut at this time, other grasses come on (June, 4th week), as *Trisetum flavescens*, *Hordeum pratense*, and intrusive *Aira caespitosa*. These are followed at the end of the month by *Phleum pratense* and species of *Agrostis* (*A. alba*, *A. stolonifera*) as the typical grasses of July. By the third week of July, all June grasses have flowered out, and only occur as residual strays.

The time for cutting the hay varies according to the state of the weather and the chances of saving it in good condition, even more than on the actual growth and fruiting of the flowering grasses; in recent years also on questions of labour-supply and expense. With continued dry weather the first fields (on Terrace Gravel) may be cut in the first week of June,² and carried the next day. Cutting is usually general in the 3rd week of June; the water-meadows being cut last. In late seasons the hay-harvest may extend into the third week of July; and in exceptionally wet summers many fields may be left till the first week of August (Pixey Mead, 1923); so that Hay Harvest may still overlap the Corn Harvest.

The complete seeding out of the earlier grasses in mid-June, and the seeding of the main crop if it is left too long, implies their thoroughly assisted dispersal during hay-making operations; and the same applies to the distribution of many of the herbaceous forms associated with the hay-crop as more or less useless weeds. Conspicuous among these is the case of the Fritillary in some alluvial meadows; also that of *Crepis taraxacifolia* on calcareous soils, and early-seeding forms as *Plantago lanceolata*, *Vicia angustifolia*, *Vicia hirsuta* on lighter pastures, and the Yellow Rattle

¹ In all grasses the inflorescence-panicles are pushed up 2 or 3 weeks before the flowers are functional; references apply to the extrusion of the anthers from the spikelets.

² The first field cut for hay (Cold Harbour), 1921, June 8; 1922, June 3; 1923, June 10; 1924, June 19, a range of 16 days.

In the dry season of 1921, all the alluvial fields had been cut and carried by June 21. In the cold late season of 1923, the first alluvial fields were cut June 25, and the heaviest crops July 8; the last, August 8. In the late season with a wet early June, 1924, the first alluvial fields July 2 (Osney and Hinksey); half the alluvial area was uncut July 15, and the last fields not all in by Aug. 1. Much of Pixey Mead was uncut by Oct. 1, and left to decay.

Cf. Ifley Lock field gave 2 crops (1921); in 1922, one crop cut too late for any aftermath, and only fully carried by Sept. 1. In 1923 the fields were cutting July 21, and in 1924, all was cut by July 17, but the whole was not all carried on July 25.

Alluvial fields (tow-path) not cut until after the third week in July become wastes of dead grass-stems, with new bottom-growth smothering other plant-forms. Waving spikes of *Arrhenatherum* are bleached and wholly seeded out. *Festuca pratensis* has seeded, as also *Lolium perenne*, *Dactylis*, and *Hordeum pratense*. The necessity of clearing the dense top-growth of coarse stems in order to encourage succulent green shoots, is possibly the initial factor in suggesting the original cutting of such alluvial tracts, and the keeping of the hay for winter use; the first hay being a waste product of nature rather than a crop, and the whole of the alluvial area cleared by fire.

It is a mistake not to cut hay in the first dry spell after mid-June; the chance of heavy rains and resultant delay, extending the hay-harvest to the beginning of August, loses the benefit of the main seeding crop. Weight per acre may be increased by bottom-growth; but the quality is deteriorated by increased percentage of wholly dead material, which may look like hay but has no feeding value.

(*Rhinanthus Crista-galli*) on clay and alluvium. All these plants thus become indirectly human associates, often occurring in vast profusion, like Daisies and Dandelions.

During the growth and harvesting of the Hay-crop, the aquatic vegetation of ditch and river continues to luxuriate under optimum conditions of light and temperature, with no check in the water-supply; this being particularly noticeable in the river with its associated streams and ditches maintained at a uniform level by the lock-system. Water-courses in the alluvium may wholly fill up with rank growth of reed and rush-forms, until the water is no longer seen, and slow streams are held up mechanically by the reed-growth (Cherwell):—

<i>Glyceria aquatica</i> , 3 ft.	<i>Phragmites communis</i> ,
<i>Sparganium ramosum</i> , 3 ft.	<i>Equisetum fluviatile</i> , 2–3 ft.

The river-bank is lined locally with *Sparganium* and *Acorus Calamus*, *Scirpus lacustris* rising from deeper water (4–6 ft.), and an abundant flora of larger Carices (*C. riparia*, *C. paludosa*). Ditches are fringed with *C. acuta* and *C. vulpina*, as well as by the preceding. The pale lilac inflorescences of *Hottonia*, standing out of the water, conspicuous in shady reaches and among the larger growths, afford one of the most graceful floral effects of the season. The closely packed blossoms of *Ranunculus circinatus* star the surface of quiet expanses; those of *R. fluitans* stream in the river-current, and whiten broad stretches where not interfered with by navigation. The first flowers of the larger forms appear as the temperature rises—*Sparganium ramosum* lining the bank-edge, *Nuphar luteum* on the surface; *Potamogeton natans* and *P. lucens* show flower-spikes rising from the water level; on the sides of ditches:—

<i>Spiraea Ulmaria</i> ,	<i>Valeriana officinalis</i> ,	<i>Nasturtium amphibium</i> ,
<i>Iris Pseudacorus</i> ,	<i>Scrophularia aquatica</i> ;	

In less degree:—

<i>Lychnis Flos-cuculi</i> ,	<i>Myosotis palustris</i> ,	<i>Nasturtium sylvestre</i> ,
<i>Veronica Anagallis</i> ,	<i>Thalictrum flavum</i> ,	<i>Nasturtium officinale</i> ,
<i>Ranunculus Lingua</i> ,	<i>Solanum Dulcamara</i> ,	<i>Glyceria plicata</i> .

A special feature of deeper water and the open river is the great development of submerged growths of *Potamogeton*:—

<i>P. lucens</i> ,	<i>P. densus</i> ,	<i>P. pectinatus</i> ,
<i>P. perfoliatus</i> ,	<i>P. crispus</i> ,	<i>P. flabellatus</i> ,

with the leafy shoots of *Elodea* and *Myriophyllum*, and the submerged ribbon-leaves of *Sagittaria* and *Scirpus lacustris*. The characteristic handsome foliage-leaves of

<i>Rumex Hydrolapathum</i> ,	<i>Sium latifolium</i> ,	<i>Alisma Plantago</i> ,
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line the banks, to flower later, and the surface of open ponds is densely packed with *Callitriche* and green Duckweed (*Lemna*); more sporadic and casual are:—

<i>Lemna trisulca</i> ,	<i>Spirodela polyrrhiza</i> ,	<i>Azolla filiculoides</i> , ¹
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Swamp-areas, in a state somewhat approximating bog-conditions,² still afford:—

<i>Pedicularis palustris</i> ,	<i>Carex pulicaris</i> ,	<i>Schoenus nigricans</i> ,
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Eriophorum angustifolium (non-fruiting), and *Parnassia* towards the end of the month. *Pinguicula* is now merely vestigial, and *Drosera* is quite extinct (as is also *Sphagnum*-bog); though these persist to a small extent in the similar formation at Cot Hill.

¹ Wolvercote and Radley.

² Bullingdon Bog, Headington Wick.

As in the case of woodland not troubled with intrusive weeds of cultivation, these aquatic stations retain much of their natural habit, with slow streams and standing water of woodland-swamp area, growing small trees of Alder, Hawthorn, and Willow (*S. cinerea*, *S. caprea*), Guelder Rose (*Viburnum Opulus*) and *Rosa canina*. Originally much of this ditch-flora spread over the entire alluvial area, and its present relegation to the water-channels (themselves largely artificial) follows annual mowing to the ditch-margin. Further deterioration ensues from the ravages of grazing cattle which crop everything they can reach, leaving in the limit a close-cut turf with little trace of flower beyond a few Daisies and Buttercups, and the shallower water-courses trampled out as drinking-places. It is interesting to note the general distribution of so many well-defined forms of the essentially aquatic genera *Potamogeton* (7), *Carex* (10), as also *Juncus* (5), as suggestive relics of an older vegetation now residual from the original valley-swamp.

On the other hand the broad pastures of the alluvial tracts which now produce nothing but a grass-crop, are seen to be populated with a mixed vegetation derived from:—

- (1) Open grass-land of the adjacent hills and downs ;
- (2) Swamp vegetation (including a few forms of damp woodland) ;
- (3) Intrusives of human association.

In the case of the grasses, and in that of their flowering associates, the limiting set of forms common to all hay-meadows is almost wholly restricted to plants of the last category ; while the obvious effect of all drainage and cultural methods is to diminish (2), to improve by selection (1), and to eliminate (3) as much as possible where valueless as food.

Flowering Plants (170) to June 21.

(1) Woodland Trees and Shrubs :—

<i>Ligustrum vulgare</i> ,	<i>Rosa canina</i> ,	<i>Rubus fruticosus</i> (forms),
<i>Lonicera Periclymenum</i> ,	<i>Rosa arvensis</i> ,	<i>Rubus Idaeus</i> ,

(2) Herbaceous Perennials of Woodland and Clearings :—

<i>Epilobium montanum</i> ,	<i>Galium saxatile</i> ,	<i>Bryonia dioica</i> ,
<i>Epilobium angustifolium</i> ,	<i>Heracleum Sphondylium</i> ,	<i>Tamus communis</i> ,
<i>Solanum Dulcamara</i> ,	<i>Malva moschata</i> ,	<i>Iris foetidissima</i> ,
<i>Digitalis purpurea</i> ,	<i>Hypericum pulchrum</i> ,	<i>Platanthera chlorantha</i> ,
<i>Vicia Cracca</i> ,	<i>Hypericum hirsutum</i> ,	<i>Poa nemoralis</i> ,
<i>Agrimonia Eupatoria</i> ,	<i>Hypericum humifusum</i> ,	<i>Festuca bromoides</i> ,
<i>Stellaria graminea</i> ,	<i>Hypericum perforatum</i> ,	<i>Aira praecox</i> ,
<i>Senecio Jacobaea</i> ,	<i>Circaea Luteana</i> ,	<i>Aira flexuosa</i> ,
<i>Inula Conyza</i> ,	<i>Crepis biennis</i> ,	<i>Carex ovalis</i> ,
<i>Lysimachia Nummularia</i> ,	<i>Jasione montana</i> ,	<i>Carex binervis</i> .

(3) Hedgerows and Roadsides :—

<i>Urtica dioica</i> ,	<i>Carduus crispus</i> ,	<i>Plantago major</i> ,
<i>Aegopodium Podagraria</i> ,	<i>Ballota foetida</i> ,	<i>Carduus lanceolatus</i> ,
<i>Chenopodium Bonus-Henricus</i> ,	<i>Galium Mollugo</i> ,	<i>Daucus Carota</i> ,
	<i>Stachys sylvatica</i> ,	<i>Geranium pratense</i> ,
<i>Potentilla reptans</i> ,	<i>Malva sylvestris</i> ,	<i>Matricaria Parthenium</i> ,
<i>Senebiera Coronopus</i> ,	<i>Malva rotundifolia</i> ,	<i>Festuca rubra</i> ,
<i>Comium maculatum</i> ,	<i>Lapsana communis</i> ,	<i>Reseda Luteola</i> .

(4) Pastures (Dry, calcareous or sandy ; grazed) :—

<i>Thymus Serpyllum</i> ,	<i>Calamintha Acinos</i> ,	<i>Erigeron acris</i> ,
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Carduus nutans,
Trifolium procumbens,
Trifolium striatum,
Agrostis vulgaris,
Echium vulgare,
Anthyllis Vulneraria,

Achillea Millefolium,
Ophrys apifera,
Trifolium medium,
 (*Orobanche minor*),
Filago germanica,
Bromus erectus,

Poa compressa,
Aira caryophylla,
Koeleria cristata,
Nardus stricta,
Festuca ovina,
Festuca tenuifolia.

(5) Hay-fields and Damp Meadows :—

Festuca pratensis,
Festuca loliacea,
Festuca duriuscula,
Poa trivialis,
Briza media,

Avena pratensis,
Dactylis glomerata,
Holcus lanatus,
Bromus racemosus,
Bromus commutatus,

Cynosurus cristatus,
Lolium perenne,
Hordeum pratense,
Trisetum flavescens,
Arrhenatherum avenaceum.

Leontodon hispidum,
Thrinicia hirta,
Rumex crispus,

Carduus arvensis,
Centaurea nigra,
Crepis virens,
Trifolium hybridum,

Plantago media,
Lathyrus pratensis,
Prunella vulgaris,

(Flood Meadows)

Sanguisorba officinalis,
Alopecurus geniculatus,

Thalictrum flavum,
Oenanthe peucedanifolia,

Silaus pratensis,
Glyceria fluitans.

(6) Swamp-woodland :—

Lotus uliginosus,
Carduus palustris,
Carduus pratensis,
Triglochin palustre,

Festuca elatior,
Eriophorum latifolium,
Juncus glaucus,

Carex vulgaris,
Carex dioica,
Carex flava.

(7) Sub-aquatics of Ditch and River-bank :—

Valeriana officinalis,
Spiraea Ulmaria,
Veronica Anagallis,
Myosotis palustris,
Galium palustre,
Stellaria glauca,
Sparganium ramosum,
Apium nodiflorum,

Scrophularia aquatica,
Nasturtium sylvestre,
Nasturtium palustre,
Malachium aquaticum,
Veronica scutellata,
Polygonum amphibium,
Acorus Calamus,
Stachys palustris,

Iris Pseudacorus,
Scirpus lacustris,
Glyceria plicata,
Phalaris arundinacea,
Carex remota,
Carex ampullacea,
Carex vesicaria,
Butomus umbellatus.

(8) Aquatics of open water :—

Nuphar luteum,
Potamogeton lucens,
Potamogeton crispus.

Ranunculus circinatus,
Potamogeton perfoliatus,

Potamogeton natans,
Potamogeton pectinatus,

(9) Cultivated Fields and Allotment-areas :—

Aethusa Cynapium,
Convolvulus arvensis,
Sonchus asper,
Papaver dubium,
Bartsia Odontiles,

Knautia arvensis,
Specularia hybrida,
Melilotus officinalis,
Chrysanthemum segetum,
 (*Vicia sativa*),

Lychnis Githago,
Lolium italicum,
Bromus secalinus,
Avena fatua,
Euphorbia exigua.

(10) On Wall-tops :—

Sedum acre,
Sedum dasyphyllum,

Hieracium murorum,
Festuca Myurus,

(*Linaria purpurea*),
 (*Antirrhinum majus*).

(11) Garden-flowering Trees and Shrubs :—

Robinia Pseudacacia,
Buddleia globosa,
Spartium junceum,

Liriodendron tulipifera,
Colutea arborescens,
Fuchsia Riccartoni,

Symphoricarpus racemosus,
Cerasus lusitanica,
Veronica Traversii.



15. *Hottonia palustris*, with basal leaves of *Rumex Hydrolapathum* ;
Tow-path ditch, Binsey ; June 1, 1922.



16. Ferns in Woodland-base ; *Lastraea dilatata* and *Pteris* ; Bagley, June 5, 1923.

(12) Plants of the May list now conspicuously culminating :—

<i>Sambucus nigra</i> ,	<i>Papaver Rhoeas</i> ,	<i>Chaerophyllum temulum</i> ,
<i>Chrysanthemum Leucanthemum</i> ,	<i>Ranunculus fluitans</i> ,	<i>Rubus caesius</i> ,
<i>Trifolium pratense</i> ,	<i>Rhinanthus Crista-galli</i> ,	<i>Orchis maculata</i> .

At this culminating period of the year such lists are still open to errors as, (1) a spell of great heat may bring on many flowers precociously, (2) a spell of rain may delay the development of flower-buds, and check observations in the field, (3) first records often apply to plants growing under particularly favourable conditions, and may be a week or more in advance of the main crop.

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